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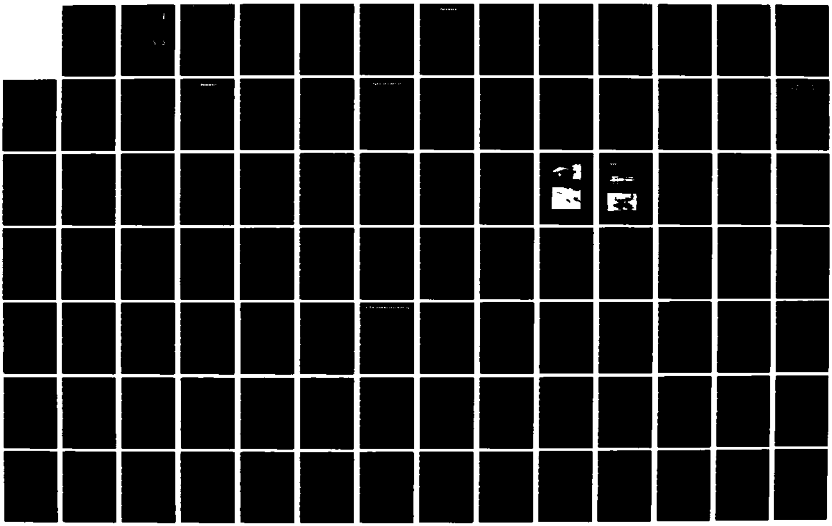

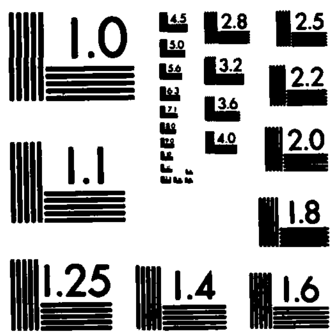

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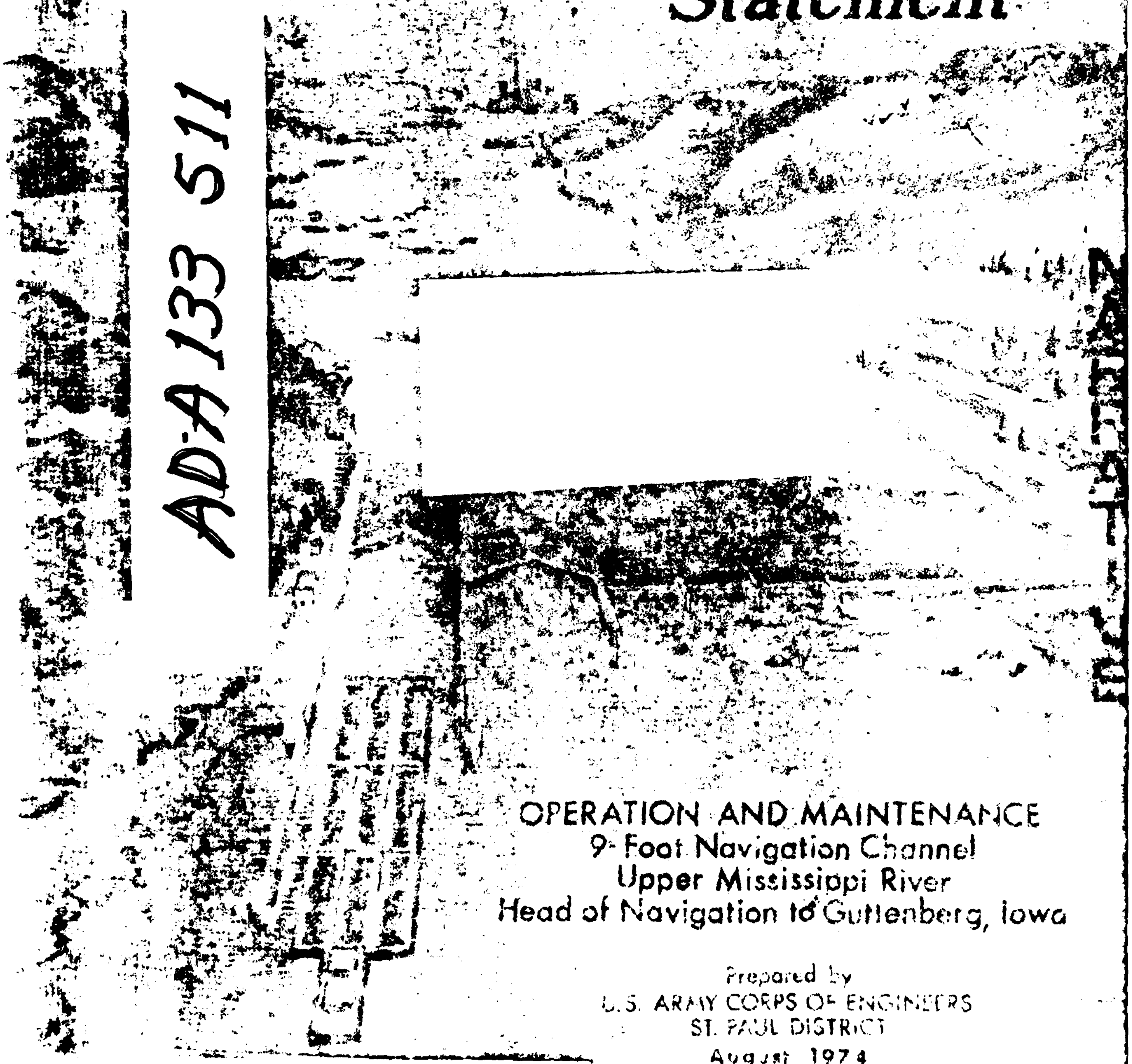

OPERATION AND MAINTENANCE
9-Foot Navigation Channel
Upper Mississippi River
Head of Navigation to Guttenberg, Iowa

Prepared by
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT

August 1974

VOL. I

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1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) FINAL ENVIRONMENTAL IMPACT STATEMENT, OPERATION AND MAINTENANCE 9-FOOT NAVIGATION CHANNEL, UPPER MISSISSIPPI RIVER HEAD OF NAVIGATION TO GUTTENBERG, IOWA. Volume I: Narrative		5. TYPE OF REPORT & PERIOD COVERED Final 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s)		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Corps of Engineers, St. Paul District 1135 USPO & Custom House St. Paul, MN 55101		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS		12. REPORT DATE August 1974 13. NUMBER OF PAGES 664 p.
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

MISSISSIPPI RIVER
ENVIRONMENTAL IMPACT STATEMENTS
NAVIGATION
CHANNELS (WATERWAYS)
DREDGING

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The major action under consideration is the operation and maintenance functions necessary to provide 9-foot channel depths for commercial navigation on the Mississippi River from Minneapolis, Minnesota to Guttenberg, Iowa. Also included is maintenance of 9-foot channel depths on 14.7 miles of the Minnesota River, 24.5 miles of the St. Croix River, and 1.4 miles of the Black River. Other proposed federal actions include: The Great River Road; The National Recreation Area; The National Wilderness Preservation System, and the Lower St. Croix Wild and Scenic River.

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The operation and maintenance of the project provides for continued commercial and recreational navigation on the uppermost 245 river miles of the Mississippi River. The aesthetics of the present river setting and the production of fish and wildlife are, to a degree, dependent upon the continued operation and maintence of the 9-foot channel. The current placement of maintenance dredge spoil requires that aquatic, semi-aquatic and terrestrial habitats adjacent to the navigation channel be converted to sandy islands which tend to eventually develop vegetation. Some of the dredge spoil is eroded and may be redeposited in entrances to backwater areas. The open, samdu spoil islands, although not developed for recreation, are subject to heavy public use. The spoil sites also support some use by wildlife, especially nesting sites for turtles.

Adverse environmental impacts results in the unavoidable loss of aquatic and terrestrial habitat. The placement of dredge spoil frequently results in dredged material spreading out into off-channel areas. Turbidity is generated during channel maintence operations, which tends to bury submerged aquatic vegetation, bottom-swelling aquatic invertebrates and fish eggs. The respiratory organs of invertebrates and fish can be damaged by excessive turbidity.

FINAL
ENVIRONMENTAL IMPACT STATEMENT

OPERATION AND MAINTENANCE
9-FOOT NAVIGATION CHANNEL
UPPER MISSISSIPPI RIVER
HEAD OF NAVIGATION TO GUTTENBERG, IOWA

NARRATIVE

Prepared by
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
August 1974

Foreword

This environmental impact statement has been prepared in accordance with Section 102 of the National Environmental Policy Act of 1969 and the existing regulations and guidelines of the Corps of Engineers and the Council on Environmental Quality. The statement deals with the operation and maintenance of the 9-foot channel navigation system on the Upper Mississippi River within the St. Paul District. It includes the Mississippi River from the head of navigation to Guttenberg, Iowa, and the affected reaches of the lower St. Croix, Black, and Minnesota Rivers. The 9-foot channel project itself and past conditions are discussed only for purposes of establishing trends to evaluate the present and future impacts of the current method of operating and maintaining the navigation system.

In the interest of clarity and presentation, this impact statement has been arranged in two separately bound volumes. This volume contains the narrative body of the impact statement, and the accompanying volume contains exhibits such as maps, tables, figures, and letters referred to in the narrative. The body of the impact statement consists of ten separate sections. Each section begins with an introduction describing the purpose of the section.

To avoid duplication, this impact statement groups the pools impounded by each lock and dam and the affected navigable tributaries into one composite statement. However, appropriate subsections (pool by pool, if necessary) have been included to deal with unique aspects.

The information presented in this statement is based on studies conducted by the St. Paul District Corps of Engineers and on a comprehensive environmental impact assessment of the 9-foot channel on the Upper Mississippi River prepared for the Corps of Engineers by a consultant. This statement is a product of compilation, correlation and analysis by an interdisciplinary team of professionals. Disciplines providing input to this statement include the following:

Biology	Economics
Civil Engineering	History - Archaeology
Water Resources Planning	Law
Wildlife Biology	Geology
Fishery Biology	Hydrology
Limnology	Hydraulics
Sociology	Sanitary Engineering
Soils Engineering	Marine Design Engineering
Recreation Planning	Plant Ecology

The detailed environmental assessment referred to above was prepared by North Star Research Institute of Minneapolis, Minnesota, assisted by a number of investigators associated with various colleges and universities located throughout the study area. Work on the assessment began in October 1972 and was completed in November 1973 at a cost of about $229,000.

The completed assessment is contained in 14 separate reports covering each pool and affected navigable tributary river reach of the navigation system. The large volume of the assessment report and the associated cost and problems of distributing such a large report precluded appending the assessment to this impact statement. However, because of the widespread interest in the assessment reports and their importance to others in conducting future studies, a full set of the reports was made available for public consultation on 29 March 1974 at each of the following locations:

WASHINGTON OFFICES

Office, Chief of Engineers
Department of the Army
Washington, D. C. 20314

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Department of the Interior
ATTN: Office of Environmental Project Review
Washington, D. C. 20240

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Dr. Sidney R. Galler
Deputy Assistant Secretary for Environmental Affairs
U.S. Department of Commerce
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U.S. Army Engineer Institute for Water Resources
Kingman Building
Fort Belvoir, Virginia 22060

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Kansas City, Missouri 64106

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Mr. Edward A. Moulder
Regional Hydrologist
Geological Survey
U.S. Department of the Interior
Building 25, Denver Federal Center
Denver, Colorado 80225

---

*NOTE: As of 1 July 1974 the designation of the Bureau of Sport Fisheries and Wildlife was changed to the U.S. Fish and Wildlife Service. This statement cites the former name of this Federal agency.

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University of Idaho
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State Office Building
Madison, Wisconsin 53702

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Madison, Wisconsin 53706

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Mr. John M. Thomas
Chairman
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Coordinator
Upper Mississippi River Conservation Commission
Rock Island County Office Building
1504 Third Avenue
Rock Island, Illinois 61201

Refuge Manager
Upper Mississippi River Wildlife and Fish Refuge
405 Exchange Building
Winona, Minnesota 55987

LIBRARIES

Minnesota

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Minneapolis, Minnesota 55401

Minneapolis Public Library
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300 Nicollet Mall
Minneapolis, Minnesota 55401

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Science & Industry
90 West 4th Street
St. Paul, Minnesota 55102

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Minneapolis, Minnesota 55414

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Madison, Wisconsin 53703

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Hudson, Wisconsin 54016

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Dubuque, Iowa 52001

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Decorah, Iowa 52101

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Bismarck, North Dakota 58501

Carnegie Library
1000 E. Church
Pierre, South Dakota 57501

Summary

Operation and Maintenance
9-Foot Navigation Channel
Upper Mississippi River
Head of Navigation to Guttenberg, Iowa

( ) Draft Environmental Statement (X) Final Environmental Statement

Responsible Office: District Engineer, U. S. Army Engineer District
1210 U. S. Post Office & Custom House
St. Paul, Minnesota 55101
Telephone Number (612-725-7505)

1. Name of Action: (X) Administrative ( ) Legislative

2. Description of Major Federal Action: The major Federal action under consideration is the operation and maintenance functions necessary to provide 9-foot channel depths for commercial navigation on the Mississippi River from the head of navigation at Minneapolis, Minnesota, to Guttenberg, Iowa, a distance of 242.5 river miles. The project also includes maintenance of 9-foot channel depths on 14.7 miles of the Minnesota River, 24.5 miles of the St. Croix River, and 1.4 miles of the Black River. The action consists of the operation and maintenance of 13 locks and dams and the necessary channel dredging and disposal of dredged material to maintain a 9-foot depth for navigation on the aforementioned reaches of the various rivers, all located within the boundaries of the St. Paul District, U. S. Army Corps of Engineers and within the States of Iowa, Minnesota, and Wisconsin. Other proposed Federal actions in the area include: The Great River Road; The National Recreation Area; The National Wilderness Preservation System; and The Lower St. Croix Wild and Scenic River.

3. a. Environmental Impacts: The operation and maintenance of the project provides for continued commercial and recreational navigation on the uppermost 245 river miles of the Mississippi River. Estimates of savings in transportation costs for bulk commodities over the other various least cost alternatives are on the order of 4.0 to 5.4 mills per ton-mile. The operation and maintenance of the project as well as the river-oriented industries contribute substantial employment and development to communities along the river. The aesthetics of the present river setting and the production of fish and wildlife are, to a degree, dependent upon the continued operation and maintenance of the project. The dredge spoil areas affect the aesthetics of the river setting, with the degree and type of impact dependent upon the individual's interpretation. The current placement of maintenance dredge spoil requires that aquatic, semi-aquatic and terrestrial habitats

adjacent to the navigation channel be converted to sandy islands which tend to eventually develop vegetation. Some of the dredge spoil is eroded and may be redeposited in entrances to backwater areas. The open, sandy spoil islands, although not developed for recreation, are subject to heavy public use. The spoil sites also support some use by wildlife, especially as nesting sites for turtles.

b. Adverse Environmental Impacts: The present method of dredge spoil placement results in the unavoidable loss of aquatic and terrestrial habitat in areas adjacent to the navigation channel and subsequent displacement of associated wildlife. The placement of spoil frequently results in dredged material spreading out into off-channel areas affecting several types of shallow aquatic habitats, as well as submerged wing and closing dams which provide excellent habitat for the production of aquatic invertebrates and fish. Some of the spoil material is eroded and may be redeposited in the entrances of flowing sloughs which are important to the biology of extensive backwater areas. Turbidity is generated during channel maintenance operations. This tends to bury submerged aquatic vegetation, bottom-dwelling aquatic invertebrates and fish eggs. The respiratory organs of invertebrates and fish can be damaged by excessive turbidity.

4. Alternatives: The broad alternative categories were classified as:

a. Cease all operation and maintenance activities.
b. Provide a navigation channel of lesser or greater depth than 9 feet.
c. Provide a 9-foot navigation channel with modifications to the existing method of operation and maintenance.

Those alternative actions to the existing method of operation and maintenance that might reduce or alleviate specific adverse impacts include the following alternative measures:

a. Watershed land treatment.
b. Sediment deposition control structures.
c. Confined disposal areas.
d. Shore protection for disposal areas.
e. Revegetation.
f. Selective placement.
g. Remote disposal.
h. Central disposal.
i. Remove from the floodplain.
j. Type of dredge.
k. Cutterhead.
l. Size of dredge cut.
m. Dredge openings into backwaters.
n. Expand dredge plant capability.
o. Permanent water level change.
p. Temporary water level change.

q. Change control point in pool.
r. Provide fish passageways.
s. Provide low flow outlets.
t. Revise locking priorities.
u. Provide other passages for recreational craft.
v. Commercial use of dredge spoil.
w. Recreational use of dredge spoil.
x. Wildlife habitat use of dredge spoil.

Several of the alternative measures from the above list were combined as alternative plans which would reduce or eliminate the majority of the adverse impacts of the present operation and maintenance activities. Those alternative plans were evaluated and compared to the status quo operations on both an overall and individual pool basis and are listed below:

a. Status quo.
b. Selective placement.
c. Remote disposal.
d. Central disposal.
e. Remove from the floodplain.

5. Comments Requested: A list of those who received the draft statement for review and comment and a list of those from whom comments were received is given in Section 9, Coordination.

6. Draft statement to CEQ: 22 March 1974

7. Final statement to CEQ:

Table of Contents

FINAL

ENVIRONMENTAL IMPACT STATEMENT
OPERATION AND MAINTENANCE 9-FOOT NAVIGATION CHANNEL
UPPER MISSISSIPPI RIVER
HEAD OF NAVIGATION TO GUTTENBERG, IOWA

SECTION 1

1. Description of Major Federal Action

INTRODUCTION

1.01 This section of the impact statement describes the operation and maintenance of the 9-foot navigation channel project on the Upper Mississippi River from the head of navigation, river mile 857.6,* to Guttenberg, Iowa, river mile 615.1 as shown on Exhibit 1. The Congressional authorities for operation and maintenance and construction of the 9-foot channel and related works are discussed. Detailed descriptions of the maintenance of the structures and appurtenant works, the maintenance dredging and spoil disposal methods including descriptions of the equipment used, and the operation of the dams are presented. Other existing and proposed projects that are related to the operation and maintenance of the 9-foot channel project, and their relationship and compatability with the 9-foot channel project are described.

THE 9-FOOT NAVIGATION CHANNEL PROJECT

1.02 Navigational problems on the Mississippi River were recognized as early as 1824 when the Federal Government authorized removal of snags, shoals, and sandbars; excavation of rock in several reaches of rapids; and closing off of meandering sloughs and backwaters to confine flows to the main channel and thus assure more adequate depths for navigation in times of low water. The first comprehensive improvement of the river for navigation was authorized by the River and Harbor Act of 18 June 1878 to obtain a 4½-foot channel from the mouth of the Missouri River to St. Paul, Minn. A 4½-foot channel was maintained by means of constructing dams at the headwaters of the Mississippi River to impound water for low flow supplementation, bank revetments, closing dams, and longitudinal dikes. In 1890 the 4½-foot channel was extended to Minneapolis, requiring removal of boulders and dredging of bars. In 1907, a 6-foot channel was established in response to the River and Harbor Act of 2 March 1907. The additional depth was obtained primarily by construction of rock and brush wing dams, low structures extending radially from shore into the river for varying distances to constrict low water flows. Usually the shore on the opposite side of the river from the wing dams was protected with rock so water flowing around the ends of the wing dams did not erode the opposite shore. The 6-foot channel was further improved by construction of lock and dam No. 2, completed in 1930.

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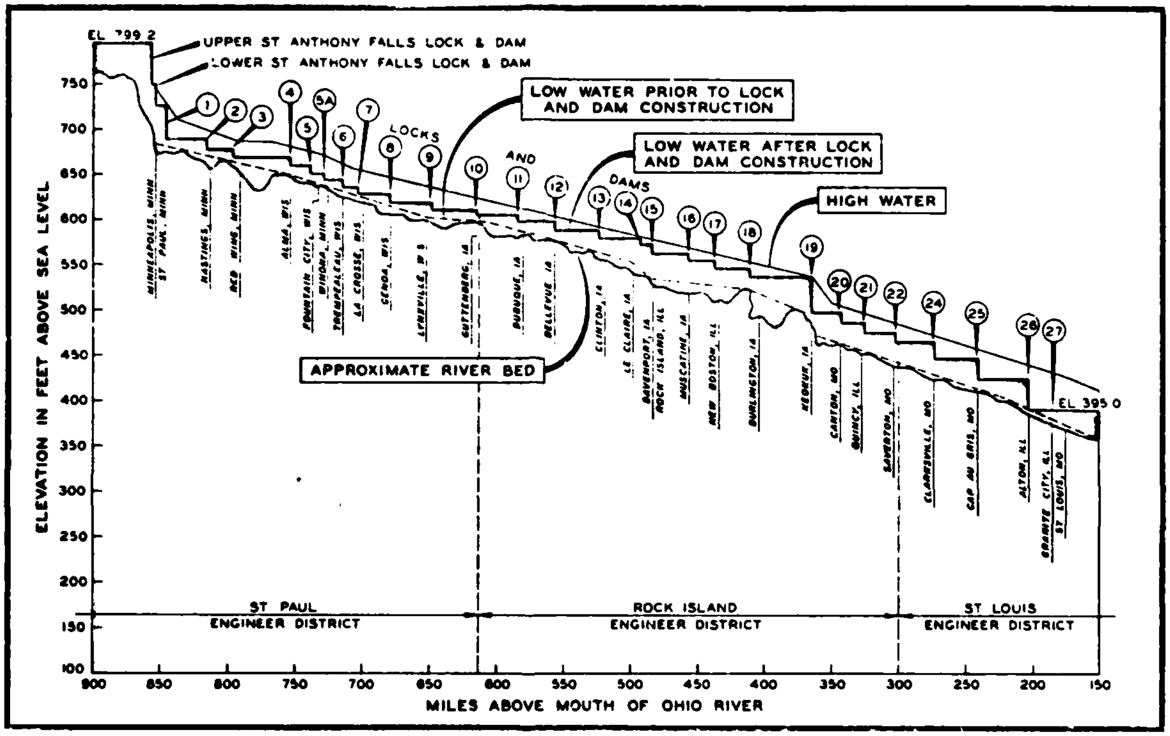
* Unless otherwise noted, all river mileages in this report are referred to miles above the mouth of the Ohio River.

1.03 The twentieth century brought advancements in engineering knowledge and techniques which were to greatly increase commerce on the nation's inland waterways. The advantages of new ideas in lock and dam construction, particularly the roller gate dam, were being tested and proven in this country and abroad. Perhaps most important of all, diesel-powered river vessels of greatly increased power and efficiency were developed, capable of pushing a dozen or more heavily-laden steel barges. With these new concepts of inland waterway navigation, it soon became apparent that the Upper Mississippi valley region could greatly benefit from the advantages of long-haul, low-cost water transportation if a dependable channel of 9-foot depth could be provided on the upper river to accommodate the large tows and powerful towboats being used on the Ohio and the lower Mississippi Rivers. The inland waterways would then form one great integrated system to the economic advantage and development of the entire nation.

1.04 In 1930, after extensive studies by the Corps of Engineers of the great river's potential as a modern transportation artery, Congress authorized the 9-foot channel navigation project on the Upper Mississippi River, embracing that section of the stream between the mouth of the Missouri River and Minneapolis. The authorizing legislation (River and Harbor Act of 3 July 1930) provided for a navigation channel of 9-foot depth to be achieved by construction of a system of locks and dams supplemented by dredging. In 1937 Congress authorized a 4.6-mile extension of the project at its upstream end at Minneapolis so as to ascend the Falls of St. Anthony (River and Harbor Act of 26 August 1937). Although the majority of the locks and dams were constructed in the decade 1930-1940, the opening of the upper lock at St. Anthony Falls to navigation in 1963 placed in operation all 29 locks and dams of the 9-foot channel project. A profile of the river from below St. Louis to above Minneapolis is shown on the following page.

1.05 As shown on Exhibit 1 and on the profile, that portion of the 9-foot channel project under the jurisdiction of the St. Paul District extends from lock and dam No. 10 at mile 615.1 at Guttenberg, Iowa, to mile 857.6 above St. Anthony Falls near the northern city limits of Minneapolis, a distance of 242.5 miles. The operation and maintenance of the 9-foot navigation channel in this reach of the Mississippi River is the subject of this Environmental Impact Statement. Authorizing legislation for the 9-foot channel project and miscellaneous work on the Mississippi River in the St. Paul District is shown in the tabulation on page 4.


EL 799.2
UPPER ST ANTHONY FALLS LOCK & DAM
LOWER ST ANTHONY FALLS LOCK & DAM
LOW WATER PRIOR TO LOCK AND DAM CONSTRUCTION
LOW WATER AFTER LOCK AND DAM CONSTRUCTION
HIGH WATER
APPROXIMATE RIVER BED
LOCKS AND DAMS
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ELEVATION IN FEET ABOVE SEA LEVEL
MILES ABOVE MOUTH OF OHIO RIVER
ST PAUL ENGINEER DISTRICT
ROCK ISLAND ENGINEER DISTRICT
ST LOUIS ENGINEER DISTRICT
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AUTHORIZING LEGISLATION, MISSISSIPPI RIVER NAVIGATION, ST. PAUL DISTRICT

Acts	Work Authorized	Documents
September 22, 1922	Dredging channels to landing places.	None
July 3, 1930 as amended by P.R. No.10, Feb 24,1932	Project adopted from Illinois River to Minneapolis; Chief of Engineers granted discretionary authority to make such modification in plan as may be deemed advisable.	H.Doc. 290, 71st Cong. 2d Session
June 26, 1934	Operation of snag boats and operation and care of locks and dams to be provided for with funds from Department of the Army appropriations for rivers and harbors.	None
August 30, 1935	Missouri River established as lower limit of project.	H.Doc. 137, 72d Cong. 1st Session
August 26, 1937	Extension of 9-foot channel above St. Anthony Falls, Minnesota, including adequate terminal facilities for Minneapolis, Minnesota.	H.Doc 137, 72d Cong. 1st Session
August 30, 1935	St. Paul Harbor	Rivers and Harbors Committee Doc. 44, 74th Cong., 1st Session
December 22, 1944	Public park and recreational facilities.	None
March 2, 1945	Red Wing, Minnesota, harbor.	H.Doc. 103, 76th Cong. 1st Session
March 2, 1945	Remedial works to correct damages caused by seepage and backwater at Cochrane, Wisconsin.	H.Doc. 137, 76th Cong. 1st Session
March 2, 1945	Such changes or additions to payments, remedial works, or land acquisitions authorized by River and Harbor Act of Aug. 26, 1937 (River and Harbor Committee Doc. 34, 75th Cong., 1st Session), as Chief of Engineers deems advisable.	None
March 2, 1945	St. Paul, Minnesota, channel enlargements small boat harbor, and roadway.	H.Doc. 547, 76th Cong. 3d Session
None	Vertical bridge clearance at Minneapolis to 26 feet above estimated stage for discharge of 40,000 cfs.	S.Doc. 54, 77th Cong. 1st Session
March 2, 1945	Winona, Minnesota, harbor basins.	H.Doc. 263, 77th Cong. 1st Session
March 2, 1945	Future modification of lock and dam No. 2 for power development.	H.Doc. 432, 77th Cong. 1st Session
March 2, 1945	Provides for cash contribution by local interests in lieu of alteration of privately owned bridges and utilities for St. Anthony Falls project.	H.Doc. 449, 73th Cong. 2d Session
July 24, 1946	Lake City, Minnesota, harbor	H.Doc. 511, 79th Cong. 2d Session
July 24, 1946	Wabasha, Minnesota, harbor	H.Doc. 514, 79th Cong. 2d Session
July 24, 1946	Payment of damages caused by backwater and seepage, pools 3 to 11.	H.Doc. 515, 79th Cong. 2d Session
July 24, 1946	Hastings, Minnesota, harbor	H.Doc. 559, 79th Cong. 2d Session
July 24, 1946	Lansing, Iowa, harbor	S.Doc. 192, 79th Cong. 2d Session
May 17, 1950	Alma, Wisconsin, harbor.	H.Doc. 66, 81st Cong. 1st Session
May 17, 1950	Prairie du Chien, Wisconsin, harbors	H.Doc. 71, 81st Cong. 1st Session
May 17, 1950	Permits such change in location of Winona, Minn., small boat basin authorized by River and Harbor Act of Mar 2, 1945 (H.Doc. 263, 77th Cong., 1st sess.), as Chief of Engineers deems advisable.	None
September 3, 1954	Construction of Crooked Slough Harbor at Winona, Minn., in lieu of previously authorized commercial harbor.	H.Doc. 347, 83d Cong. 2d Session
July 3, 1958	Permits modification of vertical bridge clearances and authorizes completion of St. Anthony Falls project.	H.Doc. 33, 85th Cong. 1st Session
March 3, 1909	Reconstruction of structures as may be necessary to provide adequate facilities for existing navigation.	None
July 14, 1960	Construction of industrial harbor at Red Wing, Minnesota.	H.Doc. 32, 86th Cong. 1st Session
October 23, 1962	Construction of small-boat harbors at Savanna, Moline, Andalusia, New Boston, Warsaw, Quincy, and Grafton, Ill.; Bellevue, Clinton, Davenport, and Keokuk, Iowa; St. Paul (Harriet Island), Minn.; and Bay City, Pepin and Cassville, Wis.	H.Doc. 513, 87th Cong. 2d Session
November 7, 1966	Repair of Stone Arch bridge at Minneapolis, Minnesota.	None

1.06 The majority of lock chambers for the 9-foot channel navigation project within the St. Paul District are of the same dimension, namely 110 feet wide and 600 feet long. Exceptions, however, are the upper and lower locks at the Falls of St. Anthony, which are 56 feet by 400 feet; lock No. 1, which has twin locks each 56 feet by 400 feet; and lock No. 2 which has a riverward lock of 110 feet by 500 feet while the landward lock is the standard 110 feet by 600 feet. With the exception of the upper lock at St. Anthony Falls, lock and dam No. 1 and lock and dam No. 2, all other dams in the St. Paul District have provisions for future construction of an additional lock if required. The height a vessel is lifted or lowered in a lock (lift) differs widely according to location. For example, the upper lock at St. Anthony Falls has a lift of 49.2 feet while lock 5A has a lift of 5.5 feet. The locks fill and empty by gravity, no power being required except for operation of the machinery controlling the valves and gates.

1.07 The dams of the project are generally low structures with the exception of the upper and lower St. Anthony Falls dams and dam No. 1. The dams are primarily for navigation purposes. However, limited power facilities are located at the upper and lower St. Anthony Falls dams and lock and dam No. 1. The low heights of the other dams in the St. Paul District preclude economical water power development and any flood control benefits. In most of the dams, a combination of roller gates consist of large steel cylinders which roll on tracks slightly inclined from the vertical, imbedded in recesses in the concrete piers of the dam. Tainter gates in their simplest form consist of a segment of a cylinder supported at each end by radial arms rotating on pins anchored in the supporting piers. Both types of gates, being movable, can be adjusted to control pool levels in times of normal and low flows. During flood periods the gates are lifted entirely above the water level, and the dam structure then causes only slight obstruction to the flow of the river. In addition to the lock and gated sections, most structures also have earth dikes of varying lengths. In some cases the dikes also include an overflow section and low flow culverts. Details concerning the locks and dams are shown in Exhibits 2 through 27.

1.08 In addition to the main stem channel improvements, three Mississippi River tributaries have been improved for commercial navigation in the St. Paul District. These improvements on the Minnesota, St. Croix, and Black Rivers are shown in Exhibits 28, 29, and 30, respectively, and are discussed in the following paragraphs.

1.09 The navigation project on the Minnesota River consists of channel improvement from Shakopee to the mouth. The Corps maintains a 9-foot channel, generally at a minimum width of 100 feet with additional widening at bends and passing reaches, from the mouth upstream to near Savage, a distance of 14.7 miles, and a 4-foot channel from mile 14.7* to mile 25.6* at Shakopee. However, the Peavy Company normally dredges the channel to a total depth of 9 feet between miles 14.7* and 21.8*. The navigation channel in the Minnesota River was obtained and is now maintained by dredging only. A minimum water surface elevation of 687.2** is maintained upstream to Shakopee by lock and dam No. 2. Congress authorized the 9-foot channel in the Minnesota River in the River and Harbor Act of 3 July 1958. The 4-foot channel, between miles 14.7* and 25.6* , was authorized by Congress in the River and Harbor Act of 13 July 1892.

1.10 The project on the St. Croix River (Exhibit 29) consists of a 9-foot channel for commercial navigation from the mouth to Stillwater, a distance of 24.5 miles. A 3-foot channel is authorized from Stillwater to Taylor's Falls, Minnesota, mile 51.8***, but is not actively maintained. The level of the St. Croix River navigation channel is controlled by lock and dam No. 3 at Red Wing, Minn. The 3-foot channel on the St. Croix was authorized in the River and Harbor Act of 18 June 1878, and a 6-foot channel to Stillwater was authorized in the River and Harbor Act of 21 January 1927. The present 9-foot channel on the St. Croix was authorized in the River and Harbor Act of 30 August 1935. The 9-foot depth was assured as a result of construction of lock and dam No. 3 which was completed in 1938.

1.11 The River and Harbor Act of 26 August 1937 authorized a navigation channel on the Black River in Wisconsin. The authorization provides for a depth of 9 feet below the normal elevation of pool No. 8 between the mouth of the Black River and a point 1.4 miles above its mouth. Dredging of a channel about 300 feet wide which is considered adequate for existing commerce was completed in 1941.

AUTHORITY FOR OPERATION AND MAINTENANCE PROJECT

1.12 Basic authorities for the operation and maintenance of the 9-foot channel project are contained in authorizing legislation by the Congress for the construction of its various elements. The essential authorization is contained in the River and Harbor Act of 3 July 1930 which authorizes maintenance of the 9-foot channel in accordance with

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* Miles above the mouth of the Minnesota River

** All elevations are referenced to msl 1912 adjustment unless otherwise noted.

*** Miles above the mouth of the St. Croix River

the plan contained in House Document 290, 71st Congress, 2d Session. The authority of the Corps of Engineers was expanded somewhat by the River and Harbor Act of 24 February 1932 to permit modification of the project "as in the discretion of the Chief of Engineers may be advisable". In addition to the referenced acts, Congress has continued to appropriate funds for maintenance and operation work. While an appropriations act in itself cannot be considered to be an authorization, the continued annual appropriations certainly is evidence of tacit approval on the part of Congress for operation and maintenance during the past 35 years. The annual expenditures for operation and maintenance of the 9-foot channel project for the period 1969 through 1973 is given in the following table:

Operation and Maintenance Costs of the 9-Foot Channel Within the St. Paul District(1)

Year (2)	Amount
1969	$3,160,000
1970	3,800,000
1971	4,700,000
1972	4,560,000
1973	5,840,000

(1) Costs include overhead costs.
(2) Calendar Year.

MAINTENANCE OF THE LOCKS AND DAMS

1.13 The locks and dams were designed and constructed to provide a minimum depth of 9 feet for navigation. In order to continuously provide this depth as directed by Congress, programmed operations of each lock and dam are projected and followed. In spite of all planning efforts, annual maintenance dredging of the navigation channel to remove accumulated sediment is necessary to permit passage of vessels requiring 9-foot draft.

1.14 General maintenance operations normally performed at the locks and dams can be broken down into several main categories common to all sites except the St. Anthony Falls locks and dams and lock and dam No. 1 locations. These excepted projects do not include earth dikes, movable dam sections (except Lower St. Anthony Falls lock and dam), employee dwellings and excessive esplanade areas that are found at locks and dams 2 through 10. Routine maintenance normally required at various structures is discussed in the following paragraphs.

LOCKS AND GUIDE WALLS

1.15 Replacement of deteriorated or damaged concrete, wall armor, and protection angles are some of the day-to-day maintenance items required in these areas. Painting of handrailing, grating, and protective steel is accomplished on an as required basis, as is the repair of lock gates, valves, and associated machinery. Damaged or deteriorated water seals on gates and valves are replaced as needed. Timbers on the lock gates are replaced when deteriorated or when damaged by accident. Lubrication of operating machinery is done on a scheduled basis. A detailed underwater inspection of each lock and its gates is performed annually. The present maintenance program requires that each lock undergo a major inspection at 15-year intervals. Lock gates and valves are sandblasted and repainted, drain holes are cleaned, damaged and/or deteriorated concrete and steel is repaired or replaced and necessary structural repairs are made during this operation. Other routine maintenance activities include replacement of electric lamps on lock lighting systems, repair and/or replacement of signs located along lock and guide walls, and electrical maintenance of operating motors and control systems. Major structural repair of accident damage has included replacement of an entire miter gate or replacement of the end of a concrete guide wall. Scour repair may include placing of fill and/or riprap underwater to prevent undermining of guide walls or of the sills above and below the lock gates. To prevent ice pressure against the gates in winter, ice formed in front of the gates is either chopped by hand or removed by heaters, circulating pumps, or a bubbler system.

MOVABLE DAM SECTIONS AND SERVICE BRIDGES

1.16 Painting of roller and tainter gates, service bridge structures, handrail and grating results in a major portion of the maintenance expended on the dam sections and service bridges. Repair of deteriorated concrete on the bridge and gate piers and storage yard areas is accomplished as required. All sites, except Upper St. Anthony Falls and locks and dam No. 1, have either a locomotive crane or hoist cars operating on the service bridge requiring routine mechanical maintenance, inspection, and painting. Gate operating machinery is lubricated periodically. Other maintenance required in these areas includes replacement of electric lamps and repair of electric operating and control equipment. Pier house roofs are repaired or resurfaced on an as required basis. Areas of the riverbed above and below the dams are sounded annually to determine if scour damage is present. Repairs are made immediately if it is determined that a threat to the structural integrity of the dam exists. Scour repair consists of placing fill and/or riprap and derrick stone underwater above or below the dam. Elimination of weeds and repair to riprap and fencing around storage yard areas require some maintenance effort on an as needed basis. The chains for gates in the dam occasionally require repair or replacement.

To move the gates in the winter, ice must be removed along the seals by chopping or using heaters.

EARTH DAMS, DIKES, AND SPILLWAYS

1.17 Normal maintenance of earth dikes consists of periodic brush removal, repair of deteriorated top surface, and replacement of riprap. Cleaning and repair of culverts and sluiceways in the overflow sections of the earth dams is accomplished as required. Some replacement of rock and grout is required periodically at some locations such as the Onalaska Dam adjacent to lock and dam No. 7. Repair of deteriorated concrete and the painting and repair of handrailing, fencing, and signs are the major work required at the concrete spillways. The areas above and below the overflow dams are sounded annually to determine the stability of the dam. Necessary scour repairs are made as previously described.

BUILDINGS, ROADS AND GROUNDS

1.18 Normal maintenance of employee dwellings, shops, central control stations, and visitor facilities is accomplished by lock personnel. Extensive rehabilitation work such as replacement of roofs, major painting projects, new sewage systems, and repairs to water wells and pumps, is completed through contract.

1.19 The lock operating personnel make day-to-day repairs to roads but complete resurfacing, seal coating, and other major rehabilitation work is done by contract. Routine mowing, seeding, snow removal and related work is performed on a continuing basis by lock operating personnel.

PUBLIC USE AREAS

1.20 General maintenance includes collecting garbage, cleaning picnic tables and privies, grass mowing, and repair of access roads, parking areas, and boat ramps.

DETAILED DESCRIPTION OF MAINTENANCE DREDGING AND SPOIL DISPOSAL

1.21 The St. Paul District, U.S. Army Corps of Engineers, maintains 9-foot channel depths on 242.5 miles of the Mississippi River, 14.7 miles of the Minnesota River, 24.5 miles of the St. Croix River, and 1.4 miles of the Black River for a total of 283.1 river miles. In addition, the St. Paul District dredging plant performs maintenance dredging on 314 miles of the Mississippi River for the Corps' Rock Island District.

1.22 Minimum channel dimensions maintained in the St. Paul District on tangent (straight) sections of the river are:

Mississippi River lock & dam No. 2 to lock & dam No. 10	- 300 feet
Mississippi River lock & dam No. 2 to mile 857.6	- 200 feet
St. Croix River	- 300 feet
Minnesota River	- 100 feet
Black River	- 300 feet

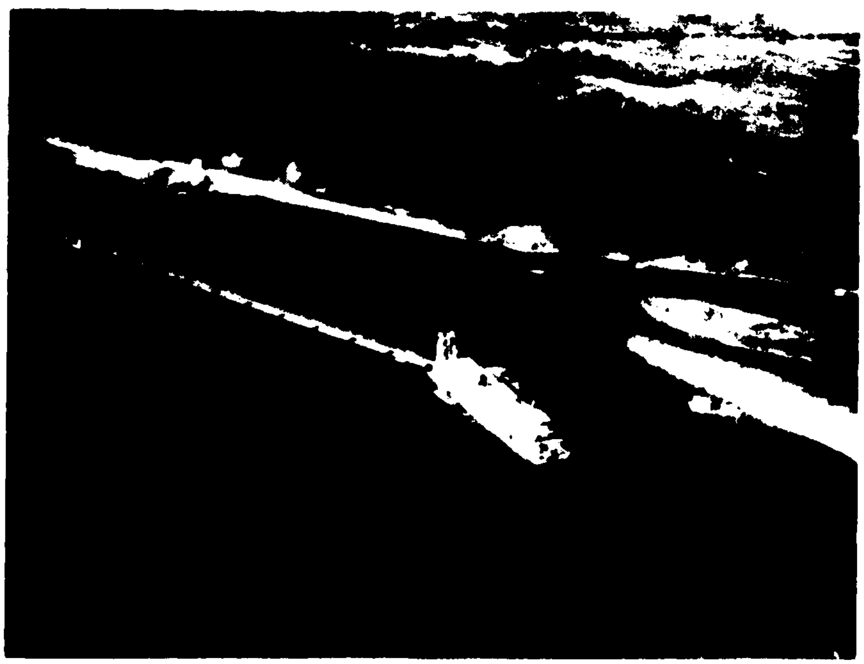
1.23 Channel dimensions on bends are widened up to a maximum of 550 feet depending on the degree of curvature. In order to insure a 9-foot channel depth, overdepth dredging to 11 feet is often required. Experience has shown that due to the squat of towing vessels and their propeller wash effect, depths less than 11 feet can change to about 7 feet in a short period of time closing commercial navigation. Therefore, whenever the channel shoals to a depth of 11 feet or less, maintenance dredging requirements are reviewed closely and anticipated. An additional 2 feet of overdepth dredging to 13 feet is normally accomplished to allow a reasonable period between maintenance requirements. The Minnesota River channel is normally dredged to a depth of 12 feet when required. The additional overdepth dredging as previously described is limited to 1 foot on the Minnesota River due to bank stability considerations.

1.24 Channel maintenance and disposal of dredged materials are solely a Federal responsibility except in the Upper St. Anthony Falls pool and the lower 14.7 miles of the Minnesota River, where the city of Minneapolis and the Lower Minnesota River Watershed District, respectively, accepted responsibility for providing dredge disposal sites as a condition of local cooperation in connection with construction of the project.

1.25 Channel maintenance dredging is normally accomplished with the DREDGE WILLIAM A. THOMPSON and the DERRICKBARGE HAUSER (formerly DERRICKBOAT 767). The dredge and derrickbarge are shown in the photographs on the following pages.

1.26 The DREDGE WILLIAM A. THOMPSON, a 20-inch hydraulic dredge, is 267 feet long from the tip of the cutterhead to its stern, 48 feet wide, and has a minimum bridge clearance elevation of 52 feet 9 inches. The dredge has a 22-inch intake and a 20-inch discharge. Its pump is driven by an 1,800 horsepower diesel engine. The remaining operating equipment is driven electrically from current supplied by two 850 horsepower engine driven DC generators. The dredge has a 56-man complement to allow operation on a three crew (24 hours per day, 5 days a week) basis. A 66-man staff allows operation of the DREDGE THOMPSON on a four crew (7 days, 24 hours per day) basis. During recent years a 55-day utilization period on a 5 days

DREDGE WILLIAM A. THOMPSON



DREDGE WILLIAM A. THOMPSON

DERRICKBARGE HAUSER

DERRICKBARGE HAUSER

per week operation and 145 days on a 7 days per week operation have been normal. Subsistence and quarters facilities are provided for the crew on board the dredge. The DREDGE THOMPSON sweeps the channel utilizing two anchoring spuds at its stern. The spuds are made of cast steel pipes 49 feet long and 2 feet 8 inches in diameter. Lateral movement of the dredge is controlled by hauling winches near its bow which are cable connected to remote anchors. Working in combination, the spuds and hauling winches give the THOMPSON the ability to swing from one side of the dredge cut to the other as it works into the face of the cut. Attendant plant to the dredge includes 1,751 feet of floating pontoon line, 900 feet of shorepipe, three tenders, five deck cargo barges, and two fuel barges. Using the available pontoon line, dredged material can be moved approximately 1,600 feet upstream or downstream from the dredge cut to an adjacent disposal area. The 900 feet of shorepipe is utilized to transport the material inland. Throughout the season, the DREDGE THOMPSON averages approximately 1,200 cubic yards per pumping hour and an average of 17,000 cubic yards per day which includes mobilization and demobilization time. The dredge slurry consists of approximately 20 to 30 percent solids and 70 to 80 percent water. The pump has a capacity of approximately 25,000 gallons per minute combined slurry under normal conditions which is equal to approximately 50 cfs (cubic feet per second). The daily rental rate in fiscal year 1973 for the dredge THOMPSON was an operating rate of $4,200 per day on a 5-day basis and $5,100 per day on a 7-day basis. The plant replacement costs of $392 per day and costs for deferred salaries of $112 per day are in addition to the operating rate. This rental rate includes the total operating costs and plant maintenance costs consisting of salaries, materials, supplies, depreciation, etc. The rate fluctuates year to year due to variance in use and repair costs.

1.27 The DREDGE THOMPSON dredges approximately 3 million cubic yards per year of which about 1.7 million yards are dredged in the St. Paul District and approximately 1.3 million cubic yards are dredged in the Rock Island District. During the 1972 navigation season, the DREDGE THOMPSON accomplished maintenance dredging for 28.6¢ per cubic yard actual plant cost. Including the cost of surveys, inspection and supervision, overhead, and other indirect costs, results in a total cost of 32.7¢ per cubic yard.

1.28 The following table presents information on the activities of the DREDGE THOMPSON for the years 1969 through 1973 and the average for those five years. The amount of time, operating costs, volume dredged, and unit cost of dredging are presented, including a breakdown of the work between the St. Paul and Rock Island Districts.

	Activities of DREDGE THOMPSON (1)					
	Calendar Year					Five-Year Average
	1969	1970	1971	1972	1973	1969-1973
Rock Island District						
Number of Days in District	58	61	68	85	104	75
Operating Cost ($1,000)	300	208	335	425	577	369
Volume Dredged (1,000 cu yds)	979	862	1,194	1,507	1,792	1,267
Cost per cubic yard ($)	0.306	0.241	0.281	0.282	0.322	0.291
St. Paul District						
Number of Days in District	103	117	108	106	93	105
Operating Cost ($1,000)	554	613	649	609	557	597
Volume Dredged (1,000 cu yds)	1,687	1,991	1,558	1,652	1,471	1,672
Cost per cubic yard($)	0.328	0.308	0.416	0.369	0.379	0.357
Total						
Number of Days Dredging	161	178	176	191	197	180
Operating Cost ($1,000)	854	821	984	1,034	1,134	966
Volume Dredged (1,000 cu yds)	2,666	2,853	2,752	3,159	3,263	2,939
Cost per cubic yard ($)	0.320	0.288	0.357	0.327	0.347	0.328

(1) Cost figures are based on total costs which include indirect costs associated with operation of the DREDGE THOMPSON.

1.29 The DERRICKBARGE HAUSER consists of a 66-by 45-foot barge with a deck-mounted 4 cubic yard crane. The barge is equipped with three spuds (steel box section members) approximately 33 feet long which hold it in position. Utilizing the crane and its clamshell bucket attachment in coordination with the spuds, the derrickbarge can step or advance along a dredge cut. The crane is powered by a 317 horsepower diesel engine and has a lifting capacity of 55,000 pounds at a 25-foot radius. The derrickbarge has a 4-foot draft and a minimum clearance with the crane removed of 20 feet 6 inches. The derrickbarge was built in 1940, but the crane unit was replaced in 1958.

1.30 The derrickbarge attendant plant includes an office barge, four tenders, four dump scows, CRANEBARGE WADE (formerly CRANEBARGE No. 771), one D-8 dozer, one D-7 dozer, three deck cargo barges and one fuel barge. The normal operating procedure for the DERRICKBARGE HAUSER is to

dredge the material from the channel and place the material in dump scows. The dump scow is a specialized barge with compartments which permit its load to be dumped through the side by gravity. The two larger dump scows have a capacity of 165 cubic yards each while the smaller dump scows have a capacity of 110 cubic yards each. The scow loaded with material is then transported by tender to a disposal site of up to 1½ miles from the dredge site. As the dump scows' draft is approximately 6 feet when loaded, the material is dumped in a minimum depth of 6 feet and then cast on land, if required, by the CRANEBARGE WADE. The material is then moved with the dozers as required.
Under normal operating conditions the derrickbarge will produce approximately 2,400 cubic yards per day, excluding mobilization and demobilization time. The derrickbarge has a complement of 33 men which includes staffing for security during the nonoperating shifts and weekends. The derrickbarge is utilized to perform channel maintenance on the Minnesota River even though the normal maintenance requirements would allow utilization of a hydraulic dredge. The DREDGE THOMPSON cannot be used because of the limited width of channel (100-foot bottom width). Since shoaling develops so rapidly on the Minnesota River, there has not been adequate time to allow for preparation of plans and specifications, formal contract advertisement, and mobilization of contractor equipment, to permit contract dredging to date. The DERRICKBARGE HAUSER and/or attendant plant is also utilized to perform snagging in the upper reaches of the Minnesota and St. Croix River projects as separate operations. Snagging on the Mississippi River is accomplished during mobilization by the dredging equipment and sounding parties. The lock and dam forces also remove some of the snags which reach the dams. Channel maintenance in reaches above the 9-foot channel portion is not required, as normal flows provide adequate depths for light recreational craft. The derrickbarge is also dispatched to remove channel obstructions, to perform emergency structural repairs, and routine or normal scour repairs to the dams and spillways. During the winter the DERRICKBARGE HAUSER is used to perform the major rehabilitation of the lock structures.

1.31 The derrickbarge dredges approximately 250,000 cubic yards per year. The current rental rate of the DERRICKBARGE HAUSER and attendant plant is $3,000 per day for the operation, plus $27 per day for plant replacement cost, and $63 per day for deferred labor costs. This rental rate is based on utilization of the DERRICKBARGE HAUSER on a two-shift or 16 hour per day basis 5 days per week.

1.32 The following table presents information regarding the activities of the HAUSER for the period 1969 through 1973, and the average for this period.

ACTIVITIES OF DERRICKBARGE HAUSER (1)

	Calendar Year					Five-Year Average
	1969	1970	1971	1972	1973	1969-1973
Operating Costs ($1,000)	386	341	394	386	443	390
Volume Dredged (1,000 cu yds)	274	271	180	291	226	248
Cost per cubic yard	$1.41	$1.26	$2.18	$1.33	$1.96	$1.57

(1) Costs include indirect costs; yardage figures are based on net credited yardage.

1.33 The DERRICKBARGE HAUSER for the 1972 operating season dredged at a unit operating cost of $1.20 per cubic yard with a total cost of $1.33 per cubic yard including surveys, supervision and inspection, and other indirect costs. The yearly unit cost of dredging on the DERRICKBARGE HAUSER is highly dependent on the type of material and use in terms of operating shifts per day. An average unit cost of dredging on a two-shift operation is about $1.60 per cubic yard.

1.34 Channel condition soundings and surveys are initiated in the spring following partial recession from the annual spring high water. Exact time of initiation varies with the spring high water conditions but following normal high water, channel condition surveys can be initiated on approximately 1 April. When the navigation dams go back in operation (when the discharge gates are lowered into the water) one permanent survey crew is dispatched along with three emergency survey parties which are utilized for up to 2 months. These parties are made up of staff from the DREDGE THOMPSON and the DERRICKBARGE HAUSER and consist of three men and a launch. Normally one crew surveys the area from Fountain City, Wis., to lock and dam No. 7, the second surveys from Fountain City to Lake Pepin, the third surveys from the head of Lake Pepin to St. Paul. The fourth survey crew covers the area upstream from and including St. Paul and both the Minnesota and St. Croix Rivers. Each party runs sonar soundings to determine general channel conditions and to identify detail survey requirements. Following these detail surveys, the field data is plotted and dredging requirements determined.

1.35 The DREDGE THOMPSON is normally dispatched to perform initial dredging between the 20th of April and the 10th of May depending on spring high water. Normally critical jobs are accomplished on the way upstream to the Minneapolis-St. Paul area from the Fountain City service base. Upon completion of critical dredging between Fountain City and Minneapolis the THOMPSON works downstream, accomplishing all maintenance dredging requirements previously surveyed enroute to the Rock Island District. This method of operation minimizes mobilization time during the season and dovetails well with the normal maintenance requirements of the Rock Island District which is initiated about the 1st of August

and extends into October. Upon completion of the Rock Island District dredging, the DREDGE THOMPSON performs any channel maintenance cleanup dredging requirements within the St. Paul District prior to returning to winter quarters at the Fountain City service base in November. Dredging beyond this period is normally restricted due to weather conditions and related safety hazards.

1.36 The DERRICKBARGE HAUSER normally initiates its spring season between the 1st and the 20th of May. The derrickbarge is primarily utilized in the metropolitan area where disposal site limitations, bridge clearances, and/or materials do not permit utilization of the DREDGE THOMPSON. The derrickbarge also performs maintenance dredging in Mississippi River small boat and commercial harbors, performs channel maintenance dredging and snagging on the Minnesota River, and makes wing dam modifications when required. The dredging season for the DERRICKBARGE HAUSER normally terminates the 1st of October, as structural maintenance requirements occupy the remainder of the available navigation season.

1.37 As dredging requirements are determined, information concerning the proposed dredging is sent to the States of Minnesota, Iowa, and Wisconsin; the Bureau of Sport Fisheries and Wildlife; the Minnesota-Wisconsin Boundary Area Commission; and the Environmental Protection Agency. As the workload is scheduled, the data is published in a Local Notice to Navigation Interests and copies of schedules are forwarded to concerned parties. Dredge spoil sites are selected within the capabilities of the dredge and using the 1969 Dredge Spoil Survey conducted by the Upper Mississippi River Conservation Committee as a guideline in determining those areas where dredge spoil would be least damaging to the natural environment. However, in a letter dated 8 January 1974, Mr. A. C. Lopinot, Chairman, Upper Mississippi River Conservation Committee rescinded the 1969 Dredge Spoil Survey report and especially the specific site suggestions for spoil placement as designated in the report. Mr. Lopinot also stated that "written report recommendations can serve as good guidelines for interim spoil placement as long as it is understood by all that these recommendations likely represent only 'least destructive alternatives' given present dredge plant capacity restraints." Conservation and environmental interests are invited to comment on the disposal sites, and field inspections of the disposal areas are arranged as requested. Private property owners who desire dredge spoil are required to complete permit forms authorizing the Corps of Engineers to utilize their land for disposal of dredge materials. A private property owner is responsible for obtaining authority under the various State regulations from State organizations. Whenever feasible, dredge spoil is provided to the property owners. An annual dredge spoil conference is sponsored by the St. Paul District in May to coordinate dredge disposal with concerned

conservation and environmental agencies. At this meeting, the anticipated workload revealed by spring channel condition surveys is presented together with anticipated disposal sites. These conferences were initiated in 1971 at the request of the concerned agencies. Similar conferences are held in the Rock Island and St. Louis Districts to try to resolve difficult problems on specific spoil disposal areas. Since dredging in the St. Paul District begins soon after the spring flood, little specific information on channel conditions is available for this conference. Coordination concerning dredge spoil disposal has always been difficult at best due to this lack of specific information, as well as conflicting desires among fish and wildlife, recreation, State and Federal interests. Coordination is becoming more difficult as most State and Federal agencies are requesting disposal in a manner beyond current plant capabilities.

1.38 An annual coordination meeting is held with navigation interests and the U. S. Coast Guard to discuss problems concerning operation and maintenance of the 9-foot channel project as related to navigation.

1.39 Recent plant modifications include a complete contained sanitary system installed on the DREDGE THOMPSON and the DERRICKBARGE HAUSER. These systems are flush toilets with evaporators and incinerator units. The units were installed to meet State of Wisconsin requirements that no sanitary wastes be discharged into the river from any floating vessel. Also, a gyro compass has been installed on the DREDGE THOMPSON to allow minimum dredge cut layout and to prevent overswing or underswing in accomplishing dredging.

1.40 In accordance with existing regulations, the Government plant is fully utilized before any workload beyond Government capability is contracted. Maintenance dredging in the St. Paul District has required little contract dredging with the last maintenance dredging contract made in fiscal year 1970.

1.41 Drawings showing the areas where dredging has taken place and the location of spoil disposal areas since 1956 are included as Exhibits 31 through 42. Tabular summaries of the location, volume, and frequency of dredging by navigation pools are shown in Exhibits 43 through 55.

1.42 The dredge cuts and spoil disposal areas shown are only for the period 1956 through 1972 since detailed locations are not available prior to 1956. The outlines of the dredge cuts represent the areas where dredging has taken place at least once during the period. The adjacent spoil disposal areas provide an indication of the extent of the area covered or created by the resultant spoiled material. The

tabular summaries provide additional details concerning the location of the dredge cuts, the years that dredging was accomplished and by which dredge, the quantity of material, volumes of material dredged by year, the number of times dredging occurred by tenths of miles and dredged volume summaries by reaches. The dredged volume summaries include average annual totals for the period 1956 through 1972 which are representative of more recent years for which more detailed records are available. Also shown are average annual totals from the time of attainment of full pool through 1955, the period from attainment of project pool through 1972 and the period of immediate preproject dredging and initiation of project dredging until attainment of project pool. This breakdown was selected to provide data on recent dredging, and to permit separation of any preproject dredging or dredging required to attain the initial project depths and the total dredging since attainment of the pools.

1.43 As an example, on Exhibit 40 an irregular dredge cut area is shown from river mile 690 to mile 691. This represents an area where dredging has occurred at least once during the period 1956 through 1972. The material taken from this area has been spoiled in the approximate location of the pink-shaded areas adjacent to the cut. Exhibit 53 provides additional data for this same location. The top part of Exhibit 53 shows the years that dredging took place between miles 690 and 691 and the volumes removed by year. It is apparent that 27,000 cubic yards of material were removed between river miles 690.4 and 690.6 in 1961. The lower graph provides information concerning dredging frequency by location and shows that between river mile 690.5 and 690.6, dredging has been performed on 18 separate occasions between 1937 and 1972. The tabulation on the bottom of Exhibit 53 indicates that for the reach of the river between miles 689.6 and 691 during the period 1956 through 1972, 650,000 cubic yards were removed resulting in an average annual quantity of 38,200 cubic yards. During the period 1937 through 1955, 415,000 cubic yards were removed resulting in an average annual quantity of 21,800 cubic yards. The period 1937 through 1972 indicates 1,065,000 cubic yards were removed averaging 29,600 cubic yards per year. The period 1934 to 1936, which represents the construction period for the 9-foot channel in this reach shows that 39,000 cubic yards were removed for an average of 13,000 cubic yards per year.

1.44 The chart at the right of Exhibit 53 shows the volume of material removed by year for all locations in pool 8.

1.45 This information has been developed in detail for all pools below pool 1. In pool 1 and the St. Anthony Falls pools, details concerning disposal areas are lacking since much of the material is dredged by the DERRICKBARGE HAUSER, moved by dumpscows, and rehandled by the

the CRANEBARGE WADE. A summary of total dredged quantities and average annual quantities by pool for selected time periods is shown in Exhibit 56.

DETAILED DESCRIPTION OF OPERATION

1.46 The Corps of Engineers has prepared a "Master Regulation Manual for Mississippi River 9-foot Channel Projects" within the St. Paul District for operation of the dams and, for operation of the locks, uses regulations prescribed by the Secretary of the Army concerning use, administration, and navigation of the Mississippi River above Cairo, Illinois. Operation of the locks and dams is in accordance with the master regulation manual and the regulations and are described in the following paragraphs.

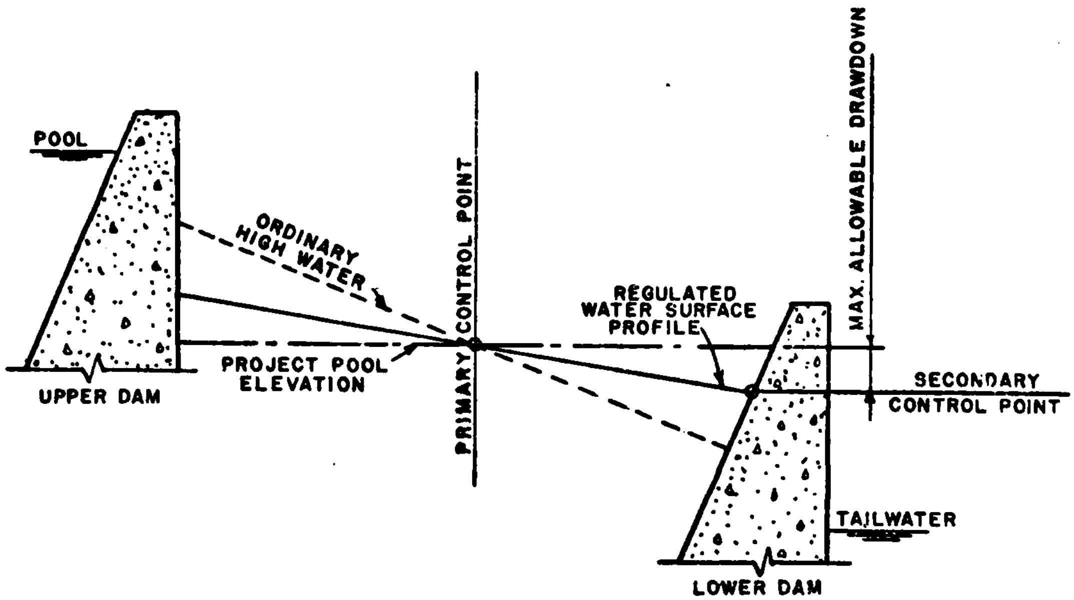
BASIC PLAN OF DAM OPERATION

1.47 If there were no flow in a pool contained by an upper and lower dam, the water surface of the pool would be level throughout its entire length. However, if flow were induced in the pool, there would be a slope in the water surface; the upstream end of the pool would rise as the discharge of the upper dam increased, and the downstream end of the pool would fall as the discharge of the lower dam increased, resulting in a drawdown at the lower dam. The water surface profile of the pool will tend to pivot about a point somewhere between the two dams. The pivot point is called the primary control point, and its location is found to be at or near the point of intersection of the project pool elevation and the ordinary high water profile. Court decisions have defined ordinary high water as follows: "where the banks of a body of water are relatively steep, ordinary high water mark is coordinate with the limit of the bed of the water; and that, only, is to be considered the bed which the water occupies sufficiently long and continuously to wrest it from vegetation and destroy its value for agricultural purposes." On navigable lakes and rivers the Government of the United States has what is called a navigational servitude under the Commerce Clause of the Constitution to utilize lands below the ordinary high water mark for maintenance of navigation.

1.48 The primary purpose of the dams in the St. Paul District is to maintain a minimum channel depth of 9 feet for navigation. To accomplish this, project pool elevations must be maintained at the primary control points. Operation of the dams is required at low and moderate flows in the Mississippi River, but the dams are not needed during high flows, and movable dams must be removed from the water before flood stages are reached. Except for the water that goes into valley storage as the inflows increase, all inflow must be discharged.

1.49 In each pool, field surveys have established both the ordinary high water profile and the location of the primary control point. Project pool elevation is maintained at the primary control point, and the pool elevation at the dam is allowed to fall as the discharge is increased. However,

the drawdown at the dam must be limited so that navigation and conservation interests in the area between the primary control point and the downstream dam will not be damaged by low water. Maximum allowable drawdown varies from zero to 1 foot in the various pools, depending on local conditions. By using this method of operation, only the area between the control point and the upstream dam will be inundated by operation of the dam, greatly reducing the cost to the government of acquiring flowage rights. The following sketch illustrates this basic plan of operation.



1.50 When the maximum allowable drawdown has been reached at the dam, control of the pool is shifted from the primary control point to the dam, and the pool is then said to be in secondary control. If, while the pool is in secondary control, the inflow continues to increase, the maximum allowable drawdown is maintained at the dam by increasing the discharge, and the stage at the primary control point and all other points in the pool is allowed to rise. As the discharge is increased, the head at the dam will be decreased; and when the head has been reduced to less than 1 foot, the gates shall be raised out of the water, and open river flow will be in effect. For primary and secondary control data see Exhibit 57.

1.51 When a pool has been in open river flow and the pool at the dam drops back to secondary control elevation, the gates shall be returned to operation, and this elevation maintained at the dam until the

stage at the primary control point has fallen to project pool elevation. Then, control of the pool is returned to the primary control point.

1.52 This method of operation is used for all pools in the St. Paul District except Upper St. Anthony pool and pool No. 1 which are controlled by power interests; Lower St. Anthony pool, which is too small to require this type of operation; pool No. 7 where all control is at the dam; and pool No. 10 where the primary control point is at the dam and the secondary control point is at Clayton, Iowa.

NORMAL OPERATION

1.53 Total inflow into a pool is the sum of discharge from the adjacent upstream pool, discharge from tributaries that empty into the pool, and miscellaneous flows such as groundwater inflow, precipitation directly into the pool, and municipal and industrial effluent. Flow-storage curves have been developed for pools 2 through 10, and from these curves the changes in storage can be obtained as changes in discharge become necessary.

1.54 Operating curves which show the elevations at the primary control point, headwater, and tailwater for all discharges and maximum allowable gate opening curves for all operating heads have been developed for pools 2 through 10. To prevent scour below the dam, the discharge velocity is limited to 4.5 feet per second (fps). Under emergency conditions a maximum velocity of 6 fps is permitted.

1.55 With the aid of the operating curves and maximum allowable gate opening curves, operating schedules have been prepared for dams 2 through 10. The operating schedules tabulate the following data for all discharges:

a. Total roller gate opening.
b. Total tainter gate opening.
c. Pool elevation.
d. Tailwater elevation.
e. Head.
f. Roller gate discharge per foot of opening.
g. Tainter gate discharge per foot of opening.
h. Total roller gate discharge.
i. Total tainter gate discharge.
j. Maximum allowable roller gate opening.
k. Maximum allowable tainter gate opening.

The gate openings have been computed so that the maximum allowable velocity will not be exceeded, and also that the discharge velocity below the dam will be uniform throughout the cross section. The

roller gate and tainter gate discharges per foot of gate opening are obtained from field measurements made at the dams.

1.56 Normally, regulation of a pool requires only small changes in the outflow to maintain project pool elevation at the primary control point. A tolerance of plus or minus 0.2 foot is allowed, so when the inflow remains steady, it is necessary only to hold the pool at the dam within this range. However, when the inflow varies considerably, flow-storage curves are used to determine the volume that must be added to or withdrawn from storage before the required discharge can be attained. Therefore, the regulating engineer has only to compute total inflow into a pool and add or subtract the change in storage to obtain the required discharge. Based on the required discharge, the operating schedule provides the gate settings, pool elevation, and all other data required for pool regulation.

WINTER OPERATION

1.57 Dams 3 through 9 have submersible roller gates to facilitate winter operation. These gates which do not develop the icing problems that occur with gates open in the normal position, can be submerged 5 feet. The roller gates at dam No. 10 are not submersible, but two of the tainter gates are.

1.58 Flow during the winter is lower and steadier than at any other time of the year. Before the freeze-up begins, the probable base flow at each project for the winter period is estimated so that the tainter gate openings can be set and the tainter gates allowed to freeze in place. The roller gates are lowered to the submerged position, and any variation from the estimated base flow is adjusted in the submerged roller gate section. In the event that an increase in discharge cannot be passed by submerged roller gates, one or more of the roller gates is raised into the normal position. All roller gates are equipped with side seal heaters, and all tainter gates at dams 5A through 10 have side seal heaters. The heaters alone seldom permit adequate ice removal from the gates to allow them to move freely so they must be chopped free or portable heaters must be utilized. At the Upper St. Anthony Falls dam and dam No. 1, the ice normally takes out the 2 feet of flashboards, and the pools drop to spillway crest or lower.

1.59 Ice cover affects discharge values obtained from rating curves and therefore the backwater effect must be taken into account in computing inflows from tributaries. Ice jams occur occasionally and can cause operation problems, but attempting to break up these ice jams by manipulating the flows at the dams has no noticeable effect.

THE ANTI-DRAWDOWN LAW

1.60 Complaints from concerned interests are often registered when high stages occur in the navigation pools. Invariably, this high

water is caused by natural conditions and not by operation of the dams. All the gates in each dam are removed from the water long before flood stage is reached, so that natural open river conditions exist during a flood period.

1.61 Whenever flooding threatens the Mississippi River valley because of high water content in the winter's accumulation of snow, many people believe that the navigation pools should be drawn down to provide flood storage capacity. There are two reasons why this drawdown is not performed, one legal and one technical. The legal reason is the so-called "Anti-Drawdown Law". The Act of Congress dated 10 March 1934 entitled "An act to promote the conservation of wildlife, fish and game, and for other purposes," as amended by Public Law 732, 16 USC 665a, on 14 August 1946 was amended by Public Law 697 on 19 June 1948 to include the following new section:

"Sec. 5A. In the management of existing facilities (including locks, dams and pools) in the Mississippi River between Rock Island, Illinois, and Minneapolis, Minnesota, administered by the United States Corps of Engineers of the Department of the Army, that Department is hereby directed to give full consideration and recognition to the needs of fish and other wildlife resources and their habitat dependent on such waters, without increasing additional liability to the Government, and, to the maximum extent possible without causing damage to levee and drainage districts, adjacent railroads and highways, farmlands, and dam structures, shall generally operate and maintain pool levels as though navigation was carried on throughout the year."

1.62 The technical reason for not drawing the pools down is the fact that the storage capacity of the navigation pools is so small in comparison to the magnitude of the flood flows that a drawdown would be refilled in a matter of hours and would not appreciably lower the stages reached by the flood.

BASIC PLAN OF LOCK OPERATION

1.63 The locks are operated to provide a safe and orderly transfer of vessels from the water level of one pool to the water level of the next pool. The regulations governing the operation of the locks are set forth by the Secretary of the Army in a publication entitled, "Regulations for Ohio River, Mississippi River above Cairo, Illinois and their tributaries; Use, Administration, and Navigation." The normal order for locking precedence is based on a "first-come-first-served" basis. Whenever more vessels than can be accommodated in the lockage arrive at the same time, precedence is given in the following order:

1. U. S. Military Vessels
2. Vessels carrying U. S. Mail

3. Commercial passenger ships
4. Commercial tows
5. Commercial fishing boats
6. Pleasure boats

In order to maintain the best utilization of the lock, however, the regulations do allow for variance in the above order of precedence if conditions at the lock so warrant.

1.64 Arrival points, or lock committal points are used to establish the order of arrival for lockage. The normal committal point of the lock to an on-coming craft varies with the craft and its respective operational characteristics, flow conditions in the river, and direction of travel, and is based primarily on the distance necessary to stop the vessel safely before entering the lock. For small pleasure boats the lock would be committed to the craft upon its arrival at the lock itself, whereas for large commercial tows, the lock would be committed to the tow at some distance away from the lock. This committal distance for a large commercial tow could be up to a half-mile away from the lock.

1.65 The lock must be alternately filled and emptied to permit transfer from one pool to the next. The locking operation takes about fifteen minutes on the average to complete a one-way lockage for a recreation craft or a single tug and tow. The locking operation can take over an hour to complete a double lockage of a large commercial tow.

MAINTENANCE OF WATER QUALITY

WATER QUALITY IMPROVEMENTS, DAMS NOS. 4 - 10

1.66 When the locks and dams of the 9-foot channel in the St. Paul District were constructed, many of the deep flowing sloughs and meandering side channels were blocked by dikes and spillways which were a part of the navigation projects. Also, some sloughs have become cut off from the main channel both by natural siltation and by spoil banks deposited during channel dredging operations. Periodic winter fish kills, resulting from low oxygen levels, occurred in many of these backwaters below the dikes and spillways. In the summer months high water temperatures, low water levels, algae blooms, and plant decomposition contribute to stagnation and occasional fish kills.

1.67 In 1947, the Bureau of Sport Fisheries and Wildlife made an investigation of the Upper Mississippi River to locate backwater areas of poor water quality that could be improved by restoration of sufficient flow. As a result, recommendations were made for alterations to seven dams in the St. Paul District. Initially, four structures were revised as follows:

Lock and dam No. 5A - In 1947, a slot 15 feet long and 2 feet deep was cut through the fixed concrete spillway. A continuous flow of 110 cfs is maintained at project pool, elevation 651.0. (In 1972 another slot with the same dimensions and characteristics was cut through the spillway.)

Lock and dam No. 5 - In November 1956, a 36-inch corrugated metal culvert was installed through the earth dike. A continuous flow of 70 cfs is maintained at project pool, elevation 660.0.

Lock and dam No. 8 - In October 1957, an arched, flat-bottomed, corrugated metal culvert, 50 inches wide and 31 inches high was installed through the left submersible dam. A continuous flow of 50 cfs is maintained at project pool, elevation 631.0.

Lock and dam No. 10 - In 1960, two slots, 5 feet long and 3 feet deep, were cut through the fixed concrete spillway. A continuous flow of 135 cfs is maintained at project pool, elevation 611.0.

1.68 In March 1961, a special study was initiated to evaluate the effectiveness of the work done to improve aeration and to show the need for similar modifications at other dikes and spillways. As a result of this study, all of the additional aeration facilities recommended by the Bureau of Sport Fisheries and Wildlife have been installed as follows:

Lock and dam No. 4 - In September 1967, a 48- inch corrugated metal culvert was installed through the earth dike. A continuous flow of 100 cfs is maintained at project pool, elevation 667.0.

Lock and dam No. 7 - In September 1967, three slots, 9 feet long and 2.5 feet deep, were cut through the fixed concrete spillway. A continuous flow of 210 cfs is maintained at project pool, elevation 639.0.

Lock and dam No. 6 - In May 1970, a slot 10 feet long and 3 feet deep was cut through the fixed concrete spillway. A continuous flow of 135 cfs is maintained at project pool, elevation 645.5.

Lock and dam No. 8 - In May 1970, an arched, flat-bottomed, corrugated metal culvert, 65 inches wide and 40 inches high was installed through the right submersible dam. A continuous flow of 70 cfs is maintained at project pool, elevation 631.0.

Lock and dam No. 9 - In May 1970, an arched, flat-bottomed, corrugated metal culvert, 65 inches wide and 40 inches high was installed through the submersible dam. A continuous flow of 70 cfs is maintained at project pool, elevation 620.0.

WINTER DISCHARGE OVER BULKHEADS, DAMS 4-10

1.69 Upon completion of the locks and dams in the St. Paul District, winter operation of the movable gates was found to be slow and difficult because of icing. Provisions for solving this problem included the installation of electrical heaters for all gates and by including some submersible gates at all projects constructed after lock and dam No. 2. The heaters have proven inadequate, and with the exception of dams No. 3 and 9, the roller gates in the submerged position do not have sufficient discharge capacity.

1.70 To overcome the deficiency of submergible gates, tests were conducted during several winter periods at dams No. 4 through 10 on discharging over bulkheads, installed so that the discharge capacity was greater than that over submerged gates. It was found by using two bulkheads, each 4 feet 2 inches deep, in a tainter gate bay and three bulkheads of the same depth in a roller gate bay that the increase in discharge capacity enabled operating the remaining roller gates in the submerged position. Since this method of operation solved most of the problems caused by ice and maintained discharge velocities within allowable limits, starting in 1946, discharge over bulkheads was made a part of winter operation.

1.71 Although this method of discharging over bulkheads in the winter reduced the problems of gates freezing in place, some disadvantages caused the abandonment of this system in 1952. Against the full operating head, insertion and removal of the bulkheads by the crane on the service bridge was rather dangerous, and difficulty in removing the bulkheads because of siltation and the high maintenance costs led to the decision to return to the original method of winter operation.

IMPROVING AERATION AT LOCK AND DAM NO. 2

1.72 Lock and dam No. 2 is located on the Mississippi River about 25 miles downstream of the Minneapolis-St. Paul metropolitan area and 21 miles and 17 miles, respectively, downstream from the points of discharge of the Minneapolis-St. Paul Sanitary District and the South St. Paul sewage treatment plants' effluents. The aeration occurring at lock and dam No. 2 has been continuously observed since the project was completed in November 1930. The past operation of the dam and a consideration of how the dam could more advantageously be operated in the future so as to aid in supplementing the dissolved oxygen (DO) content of the river were part of a cooperative research program of the Sanitary Engineering Division of the University of Minnesota Civil Engineering Department and the Minneapolis-St. Paul Sanitary District.

1.73 Wastewater components and natural organic solids discharged into a river exert a demand on the DO resources of the river. These DO resources provide the capacity for assimilation of the biochemical oxygen demand (BOD) exerted by wastewaters and natural organic solids. BOD is the amount of oxygen required to decompose a given amount of organic compounds to simple, stable substances. The DO content of a receiving river is supplemented by tributary streams, surface reaeration, photosynthesis, and aeration occurring at dams. Lock and dam No. 2 had provided a significant contribution to the assimilation capacity of the Mississippi River prior to the start of operations at lock and dam No. 3 in July 1938. However, when pool No. 3 became part of the 9-foot channel, the tailwater at dam No. 2 was raised over 6 feet and submerged the discharge apron and baffles, thus negating any prior effect the baffles may have had upon aeration.

1.74 Methods proposed for improving dam No. 2 aeration were: variation in tailwater level, advantageous operation of the tainter gates, and discharging over bulkheads instead of under tainter gates. The lowering of pool No. 3 would drop the tailwater at dam No. 2 and reduce the submergence of the apron and baffles, but this method cannot legally be used without Congressional authorization because of the "Anti-Drawdown Law".

1.75 It was observed that more turbulence occurred below the dam at a given flow when the number of gates used was reduced. As a result, dam No. 2 operation and the Mississippi River DO sampling records for a 5-year period, January 1958 through March 1963, were analyzed to determine the relationship of aeration to the number of gates employed in discharging through the dam. The analysis of this past operating data indicated that the increase in aeration would be 4 percent of DO saturation for each 100 cfs increase in the discharge per gate.

1.76 The improvement of discharge aeration by bulkheading gates was tested and is being utilized at dam No. 2. Four tainter gates were bulkheaded so that about 2.5 feet of water flowed over the crests of the weirs formed by the bulkheads. All inflow into pool No. 2 of 3,000 cfs or less is discharged over the bulkheaded gates, and when the inflow exceeds 3,000 cfs, the excess flow is discharged under the tainter gates in the normal manner to maintain the required pool stage. The bulkheads are removed only when the full discharge capacity of the tainter gates is required as in the spring ice breakup, but during this period the flows do not require aeration improvement at the dam.

1.77 A comparison of DO sample values of the 1963-1964 winter period with those of previous years with similar flows indicates that an increase

of 150 percent in aeration of the Mississippi River was obtained by discharging over bulkheads instead of under tainter gates.

INTERRELATIONSHIP AND COMPATIBILITY OF OPERATION AND MAINTENANCE ACTIVITIES WITH OTHER PROJECTS

1.78 Other existing and proposed projects, because of their interrelationship or physical proximity to the 9-foot channel project are described in the following paragraphs.

COMMERCIAL AND SMALL BOAT HARBORS

1.79 The Corps of Engineers has been authorized to construct, in cooperation with local interests, five commercial and 12 small-boat harbors on the Mississippi River in the St. Paul District. A list of these harbors and their characteristics are shown in Exhibit 58. A small-boat harbor has also been authorized to be constructed on the St. Croix River at Hudson, Wis. All authorized harbors have been completed with the exception of the Harriet Island Harbor at St. Paul and the harbor at Hudson.

1.80 The Corps of Engineers is authorized to provide maintenance dredging of the entrance channels to the harbors and also to maintain entrance channel breakwaters, where applicable. The first Federal harbors in the St. Paul District were constructed in 1949. However, no maintenance dredging was performed until 1961. Since that time, a total of 139,545 cubic yards of material has been removed from harbors in the District. All harbor maintenance dredging with the exception of Alma, Wis., has been done by the DERRICKBARGE HAUSER. Exhibit 59 provides details concerning the maintenance of the harbors. In addition to the federally-constructed harbors, many privately-owned harbors are located on the river. Details of maintenance dredging at these harbors are not readily available. However, the quantities of maintenance dredging are believed to be relatively small.

1.81 The construction and subsequent required maintenance of the commercial harbors is a direct result of construction of the 9-foot channel project. Further, the commercial harbors are a necessary adjunct to the 9-foot channel project. Most of the recreational harbors were constructed and are being maintained as a result of the 9-foot channel project. Thus, the harbors are compatible with the overall project, and since the amount of dredged material resulting from maintenance of the harbors is comparatively small, such maintenance has little or no effect on the overall project.

ST. PAUL AND SOUTH ST. PAUL, MINN.

1.82 The 1958 Flood Control Act authorized improvement of the Mississippi River at St. Paul and South St. Paul. The project is designed to protect about 1.75 miles of river frontage and 500 acres of land on the right bank in St. Paul and to protect business and industrial development at South St. Paul. At St. Paul a combined levee and floodwall parallels the right bank from about mile 838.4 to mile 840.3, and eight stop-log closure structures and five sandbag closures permit use of roads and railroads during periods of normal water stages. Three pumping plants and about 7,000 feet of interceptor and stormwater sewers have been built to pump out seepage and runoff from behind the barrier. The work at St. Paul was essentially completed in 1964. At South St. Paul a combined levee and floodwall parallels the right bank of the river between about river mile 832.2 and 834.5. Three stop-log closure structures and one sandbag closure permit normal access through the flood barrier. Two pumping plants and 7,300 feet of interceptor and stormwater sewers provide interior drainage. The project was substantially complete in 1968, and is maintained by local interests. Presence of the project places limitations on the spoiling of dredged materials in the immediate vicinity of the project levees.

COCHRANE DRAINAGE DITCH, WISCONSIN

1.83 This improvement is a modification of the 9-foot channel project to correct a seepage problem resulting from construction and operation of pool No. 5. The work consists of a drainage ditch through the swale between the Mississippi River and Cochrane, Wis., and improvement of drainage through Fountain City Slough. The ditch intercepts seepage from the direction of pool No. 5 and restores groundwater levels in the vicinity of Cochrane to a condition similar to that existing before the raising of pool No. 5. The project was completed in 1949 and local interests are responsible for maintenance.

U.S. ARMY ENGINEER SERVICE BASE, FOUNTAIN CITY, WISCONSIN

1.84 The Corps of Engineers maintains a service base at Fountain City. Maintenance of the St. Paul District floating plant is performed at the base and the floating plant is quartered at the base during the winter. The base occupies 3.6 acres along Fountain City Bay in pool 5A at about river mile 733.3.

WINONA, MINNESOTA

1.85 The 1958 Flood Control Act authorized improvements at Winona to provide a continuous flood barrier about 6.1 miles long and construction

of a pumping station, a control structure, and related facilities to provide for interior drainage. The project also provides for a public roadway and three parking areas on lock and dam No. 5A dike for recreational purposes. Work was completed in 1967. Additional work to provide protection downstream from Lake Winona is currently under study. Presence of the project places limitations on the spoiling of dredged materials in the immediate vicinity of the project levees.

UPPER IOWA RIVER, IOWA

1.86 The project, authorized by the Flood Control Act of 1954, provides a new and adequate outlet to the Mississippi River for the Upper Iowa River near New Albin, Iowa, extending from the vicinity of the Chicago, Milwaukee, St. Paul and Pacific Railroad bridge to Minnesota Slough, together with channel enlargement above the bridge for about 4 miles. Spoil material placed along the banks provides additional flood protection. The improved channel outlets near mile 671 on the Mississippi River. The project was completed in 1959 except for an upstream extension which was completed in 1964. Maintenance of the project is the responsibility of local interests except for removal of material which may be deposited in Minnesota Slough. No maintenance dredging has been accomplished in Minnesota Slough to date.

GUTTENBERG, IOWA

1.87 This project, authorized by the Flood Control Act approved 23 October 1962, provides for flood protection from high flows on the Mississippi River at Guttenberg, Iowa, by means of levees and an interior drainage system. A levee at the north end of town is about 7,500 feet long and another at the south end about 2,800 in length. Two pumping plants and appurtenant works, including temporary ponding areas, provide for interior drainage. Aesthetic and public use features for the reach along the north levee adjacent to the city parks have been provided. The facilities include stairs leading from the top of the flood barrier to the water level with connecting walkways, and a comfort station to serve both users of the park and visitors to the adjacent lock No. 10. The project will be turned over to local interests in February 1974 and local interests will then assume the responsibility for maintenance and operation of the project. Presence of the project places limitations on the spoiling of dredged materials in the immediate vicinity of the project levees.

PRAIRIE DU CHIEN, WISCONSIN

1.88 A local flood protection plan for the floodplain area of Prairie Du Chien, Wisconsin, was authorized by Congress in the Water Resources Development Act of 7 March 1974. The plan combines total floodplain evacuation with floodproofing and land use controls. The evacuation

would include the relocation of about 157 buildings and purchase of about 48 buildings. About 7 business and industrial structures and about 33 homes would have to be floodproofed. Land use controls consistent with Wisconsin floodplain management objectives would prevent unwise development from reoccurring in the evacuated area. Implementation of this project is not expected to have any significant effect on the operation and maintenance activities of the 9-foot channel project.

LA CROSSE, WISCONSIN

1.89 A feasibility report was completed by the St. Paul District in September 1973 recommending construction of a project at La Crosse, Wisconsin, to provide local protection from floods. The proposed plan provides for approximately 7.0 miles of levee, a short section of floodwall, 1.1 miles of street raise, road ramps, 11 pumping stations and ancillary collection works, 16 closure structures, three track raises, bank protection at 10 La Crosse River bridges, and modification to one La Crosse River bridge. Also included are the permanent evacuation of 40 homes on Barron Island if not done previously by the City of La Crosse, floodproofing of six commercial and industrial buildings in the industrial park area, and recreational hiking and/or bicycling trails on some sections of the levee system. This proposed project has not yet been authorized by Congress and is not expected to significantly affect the operation and maintenance of the 9-foot channel project.

PUBLIC USE FACILITIES

1.90 Fifteen public use areas have been developed by the Corps of Engineers along the 9-foot channel project in the St. Paul District. The degree of development varies from simple parking lots for fishermen to areas with boat launching ramps and basic picnic and camping facilities. Of the 15 sites developed by the Corps, 13 are now operated by other agencies.

THE UPPER MISSISSIPPI RIVER WILDLIFE AND FISH REFUGE

1.91 The Upper Mississippi River Wildlife and Fish Refuge was created by an act of Congress on 7 June 1924. The act authorized acquisition of bottomlands along 284 miles of the Mississippi River from the Chippewa River in Wisconsin to Rock Island, Ill. The Bureau of Sport Fisheries and Wildlife, U.S. Department of the Interior, is responsible for management of the refuge. Joint planning between the Bureau, the Corps of Engineers, and the various State agencies has resulted in management of these lands for the benefit of fish and wildlife and the general public.

1.92 As a result of obtaining the rights-of-way for construction and flowage for the 9-foot channel project in the St. Paul District, the Corps of Engineers has jurisdiction over 50,492 acres of fee title lands. An additional 15,448 acres are held under flowage easements, but lands under easement cannot be designated for any public use. Of the 50,492 acres, a total of 48,844 acres are under permit or lease to other Federal or State agencies and are being managed by these agencies. The Department of the Interior, under special rights, holds an additional 62,874* acres that are not connected with any acquisition action by the Corps of Engineers. Present jurisdiction and management are noted as follows:

a. Corps of Engineers jurisdiction:

Under permit to and managed by the Bureau of Sport Fisheries and Wildlife	43,574 acres
Under permit to and managed by the Bureau of Indian Affairs	1,355 acres
Under lease to and managed by the State of Minnesota	3,915 acres
Managed by Corps of Engineers	1,648 acres
Total Corps of Engineers lands	50,492 acres

b. Department of the Interior jurisdiction:

Managed by the Bureau of Sport Fisheries and Wildlife	62,874 acres*
Total federally-owned lands	113,366 acres

1.93 A considerable portion of the 113,366 acres of federally-owned land in the various pools lies below normal pool levels. Actual land area above pool levels has been determined and is shown in Exhibit 60. Exhibit 60 also shows water areas and length of shoreline in each pool. It should be noted that Exhibit 60 does not include non-Federal land within the confines of the pools.

1.94 The Upper Mississippi River Wildlife and Fish Refuge became a reality to a large degree as a result of the 9-foot channel project. Throughout the years since the establishment of the 9-foot channel project, the Corps of Engineers has attempted to maintain the project for the betterment of fish and wildlife purposes within the authorities and funding available to the Corps. For many years maintenance and operation of the project did not appear to be detrimental to

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* Latest information furnished by the Bureau of Sport Fisheries and Wildlife

successful operation of the refuge. However, more recently, fish and wildlife interests have indicated that maintenance and operation activities, primarily dredge spoil disposal, are having an adverse impact on fish and wildlife habitat within the refuge. This issue has been discussed at the annual dredge spoil conferences. There apparently is some reduction in the quality of fish and wildlife habitat within the refuge, however, the degree to which operation and maintenance activities are associated is not clear.

SECTION 2

2. Environmental Setting

INTRODUCTION

2.01 This section describes the physical and biological as well as the economic and social aspects of the Mississippi River and its navigable tributaries from the head of navigation at Minneapolis to the southernmost boundary of the Corps of Engineers St. Paul District at Guttenberg, Iowa. The 9-foot channel navigation project which for the most part has been in existence for more than 30 years is treated as part of the existing setting. Impacts directly attributable to the 9-foot channel project are discussed throughout this section and in a summary near the end of this section. Impacts attributable to the operation and maintenance of the 9-foot channel are discussed in Section 3. Also discussed in this section is the future setting without operation and maintenance of the 9-foot navigation channel and the projects and proposals of other agencies.

2.02 The navigable portions of the Upper Mississippi River considered below are part of the more extensive Upper Mississippi River basin which includes the headwaters of the Mississippi River. The headwaters is a region of dense forests, great swamps and thousands of lakes. There, at the outlet of Lake Itasca, some 1,000 air miles and nearly 2,400 river miles, north of the Gulf of Mexico, the Mississippi River begins its long journey.

2.03 From Lake Itasca the river first flows north, then east, and then in a great sweeping arc turns back to the southwest to Brainerd Minnesota, where it then flows to the south and southeast. Before reaching the Twin Cities of Minneapolis and St. Paul, Minnesota, the river flows through a broad, shallow glacial outwash valley. Below St. Anthony Falls the river is crowded into a narrow gorge, flanked with high bluffs, which extends downstream into the upper reaches of pool 2. At historic Fort Snelling, in pool 2, the Minnesota River joins the Mississippi River. In the lower reaches of pool 2 the floodplain widens for a stretch to become more like the downstream pools and there is room for shallow backwaters, low meadows and wooded areas.

2.04 Thirty miles downstream, in pool 3, another major tributary, the St. Croix River, flows into the Mississippi River at Prescott, Wis. Downstream from Prescott the floodplain again spreads out over wide, low, bottom areas. Below Red Wing, Minnesota, the river enters Lake Pepin, a naturally created river lake about 22 miles long formed by the delta of the Chippewa River. The Chippewa River joins the Mississippi River at the lower end of pool 4. The average annual discharge of the Chippewa River is 7,359 cfs.

2.05 The steep bordering hills and broad river valley which characterize this stretch of the river are particularly picturesque at Winona, Minn., in pool 6, where bluffs tower 650 feet above the city. Further downstream, in pool 7, the floodplain contains many ponds and lakes such as Lake Onalaska. Waters of the Black River flow into Lake Onalaska. The average

The average annual discharge of the Black River is 1,645 cfs. A portion of Lake Onalaska passes through the Onalaska Dam and Spillway and enters the Mississippi River downstream near La Crosse, Wisconsin.

2.06 From pool 7, to the southernmost boundary of the St. Paul District at Guttenberg, Iowa, the river flows through a valley 2 to 3 miles wide between weathered bluffs, craigs and pinnacles. Terraces, usually narrow and sometimes discontinuous, can be seen at the bases of the bluffs where they have provided places for people to settle and for towns to develop.

2.07 Below Prairie du Chien, Wisconsin, 16 river miles above lock and dam No. 10 at Guttenberg, Iowa, the Wisconsin River flows into the Mississippi River with an annual average discharge of 8,490 cfs which is greater than any of the upstream tributaries.

2.08 In the St. Paul District, the Mississippi River and its tributaries drain an area of almost 80,000 square miles, of which 45,000 square miles are in Minnesota, 32,000 square miles are in Wisconsin, and the remainder are in South Dakota and Iowa. In the St. Paul District, the Mississippi River drops almost 60 percent of its total fall. In the northwestern portion of the State of Minnesota, channels of streams have flat gradients and meander through shallow valleys. In north central Minnesota with its forest cover, flat land slopes, and large storage capacity in lakes, swamps, and reservoirs, there is no serious flood problem. However, in the southeastern part of the state, the tributaries, flowing from the prairies to the main stream, have cut deep gorges through the soft limestones and sandstones which form the bedrock in this area. The relatively high rainfall, averaging up to 32 inches per year combined with the steep gradient of the channels, cause these streams to have occasional flash floods. Soil erosion, silting, large discharges, and high velocity may cause serious problems.

PHYSICAL ASPECTS OF THE STUDY AREA

GEOLOGY

2.09 Early investigators believed that the Minnesota River valley and the valley of the Mississippi River above the Ohio River was formed following the deposition of glacial drift. Most recent investigators, however, believe that present drainage lines coincide for the most part with ancient ones formed millions of years before the Pleistocene Ice Age by preglacial erosion, which produced a well-integrated drainage system in the study area. The many tributary valleys of the Mississippi River in the Driftless Area were formed during this time. The drainage is so good that few natural lakes exist in the section except on the Mississippi River floodplain.

2.10 Beginning about 1 million years ago, the Upper Midwest entered what is commonly referred to as the Pleistocene Ice Age. The average world climatic temperature dropped at this time and several large continental glaciers developed in what is now Canada. At their maximum, these glaciers covered all of Canada east of the Rockies and extended as far south as the Ohio River. Glaciers advanced and subsequently melted four times during the Pleistocene. Each glacial episode was separated by an interglacial period having a climate at least as warm as it is today. Each glacial and interglacial period is named after an area where the geologic history of that period is especially well displayed:

- Nebraskan Glaciation (which began about 1 million years ago)
  - Aftonian Interglacial
- Kansan Glaciation
  - Yarmouthian Interglacial
- Illinoian Glaciation
  - Sangamon Interglacial
- Wisconsin Glaciation (which ended about 10,000 years ago)

2.11 Each glaciation was recorded by deposits of glacial drift that in many cases are buried by younger drift deposited by later glaciers. Scattered pockets of old glacial drift occur as far east as Winona County in Minnesota. In addition, many erratic boulders can be found that were obviously transported by glaciers. Most geologists believe that the Driftless Area of southwestern Wisconsin and southeastern Minnesota was not glaciated during the Pleistocene, but was affected by glacial meltwaters.

2.12 Pre-Wisconsin glaciers probably disrupted drainage in the Upper Mississippi River valley as much or more than the Wisconsin glaciers. Geologic evidence of such disruptions was either buried or destroyed by later glaciers or postglacial erosion.

2.13 The Wisconsin glaciation is the most recent and most important glaciation in the Upper Mississippi River basin. A detailed history of the Wisconsin stage is presented in the environmental assessment reports referred to in the Foreword and available at the locations listed on pages ii- x. Generally speaking, the advances and retreats of various lobes and sublobes of glacial ice during the phases of the Wisconsin stage were largely responsible for the formation of the present floodplains of the Mississippi River and its tributaries.

2.14 Wisconsin glacial drift covers nearly all of Minnesota, Wisconsin, and northern Iowa, except for the Driftless Area. Most of this drift was deposited during the latter part of the Wisconsin Stage, between 10 and 20 thousand years ago. Most of the drift is poorly drained as evidenced by the more than 10 thousand lakes in Minnesota that are of glacial origin. Pre-Wisconsin river valleys were, in many cases, not reoccupied following deglaciation. For instance, the Mississippi River above its junction with the Minnesota River does not follow the preglacial course, but rather one developed at the close of the Pleistocene.

2.15 During much of this period, drainage of glacial meltwaters to the north and east was blocked, resulting in tremendous flows being carried out of the region via the Mississippi River drainage system. These flows generally carried a very small sediment load compared to the size of the discharge, giving the water a great capability to erode. The valleys of the Minnesota and Mississippi Rivers, for example, were enlarged by Glacial River Warren far beyond the apparent needs of their present-day discharges. As the glaciers retreated, drainage to the north and east was reestablished. As the volume and velocity of the meltwater declined, river valleys were partially refilled by glacial outwash sediments consisting largely of sand and sandy gravel.

2.16 Subsequent stream action incised and greatly modified these outwash deposits, leaving terraces and terrace remnants along valley sides of the Mississippi River and its tributaries. Along the Chippewa River, for instance, terraces up to 100 feet high are located adjacent to the present river floodplain (Exhibit 74), serving as a nearly inexhaustible source of coarse sediments.

2.17 The Mississippi River valley was partially refilled with alluvium as the river adjusted its gradient to carry the sediments supplied by its tributaries. The gradient of the Chippewa River between its mouth and Eau Claire, Wisconsin, is about ten times greater than the present gradient of the Mississippi River between St. Paul, Minnesota, and La Crosse, Wisconsin. Thus, the Chippewa has more stream energy and can carry a coarser bedload than the Mississippi. The post-glacial Mississippi River discharge, combined with flow from Glacial River Warren, had a capacity great enough to transport all the Chippewa River sediment. As River Warren ebbed, the sediment-carrying capability of the Mississippi River also declined. As a result, a delta formed at the mouth of the Chippewa, ponding Mississippi River water and forming Lake Pepin. Zumberge, in his 1952 publication, Lakes of Minnesota - Their Origin and Classification, indicated that Lake Pepin at one time extended all the way upstream to the Robert Street bridge in St. Paul, and that postglacial deposition by the Mississippi River has filled Lake Pepin from St. Paul to Red Wing, Minnesota, a distance of about 50 miles. Lake Pepin will be continuously reduced in size over a long period of time by the advance of the delta at its head as well as by filling of the lake with silt and clay.

2.18 Zumberg compiled a summary of late-glacial and postglacial events for this segment of the Mississippi River system as illustrated in Exhibit 61 and explained below:

a. Loss of volume in the Mississippi River because of the change of outlet of Glacial Lake Agassiz, permitting the growth of a delta at the mouth of the Chippewa River.

b. The continued growth of the Chippewa delta caused early Lake Pepin to extend upstream to the Robert Street bridge in St. Paul. A

delta forms at the head of this lake, while silt and clay are deposited in the deeper, quiet waters of early Lake Pepin.

c. The Chippewa delta grows larger and higher, while the delta at the head of the lake advances downstream to the mouth of the St. Croix, burying the previously deposited silts and clays and blocking the lower end of the St. Croix Valley, thus forming Lake St. Croix.

d. The continued growth of the Chippewa delta raises the level of Lake Pepin, while the advance of the delta continues to cover previously deposited lake silts and clays.

e. Present condition of sediments in the valley as shown by Corps of Engineers borings at each lock and dam.

2.19 During postglacial time, wind was an important agent modifying the landscape. Loess, wind-deposited material derived from glacial outwash, is found on the sandy terraces along the Mississippi River and its tributaries. These deposits are very evident on the terrace between Wabasha and Minnieska, Minnesota.

2.20 The change in climate probably produced changes in the character of stream loads throughout the Upper Mississippi River basin. Prairie soils are more easily eroded than forest soils so that the suspended load of the rivers and streams in the basin increased following deglaciation. This is true for all streams in the area except the Chippewa River, which primarily drains forested areas.

GROUNDWATER

2.21 The most important aquifers in the Upper Mississippi River basin are glacially derived subsurface deposits of sand and gravel and various underlying carbonate and sandstone rock stratas.

2.22 The valley of the Mississippi River is filled with as much as 200 feet of various sediments, some of which are preserved as terraces. Within the alluvium are sand and gravel aquifers which yield more than 1,000 gallons per minute to single wells. Recharge to most aquifers is sufficient to sustain present use. Wells placed close to rivers, lakes, or streams will, in most cases, induce water to flow toward the wells.

2.23 The alluvium along most reaches of the study area yield adequate water for private wells in the floodplain. All the towns, cities and most communities downstream of the Twin Cities obtain their municipal water supplies from deep wells in the Jordan, Dresback and Hinckley sandstone aquifers. Rock formations in the St. Paul and Minneapolis area are presented as follows:

Rock Formations of the Minneapolis-St. Paul Area

Period	Formation	Average Thickness(Ft)	Apparent Range in Well Logs(Ft.)
Recent	River alluvium	-	0-150
Pleistocene	Glacial drift, etc.	100	0-400
Ordovician	Galena limestone	Top eroded	0-20
	Decorah shale	75	0-75
	Plattville limestone	30	25-35
	St. Peter sandstone with Glenwood shale on top	163	147-172
	Prairie du Chien		
	Shakopee dolomite	45	35-60
	New Richmond sandstone	11	0-15
	Oneota dolomite	80	70-90
Cambrian	Jordan sandstone	90	80-105
	St. Lawrence-dolomitic limestone and siltstone	180	160-200
	Franconia sandstone	65	45-80
	Dresback	155	125-200
	Galesville sandstone		
	Eau Clair sandstone		
	Mt. Simon sandstone		
Upper Pre-Cambrian Keweenawan	Hinckley sandstone	220	-
	Fond du Lac Beds (Red classic series)	1,012	-
	Volcanic rock-undivided	-	-
Lower Precambrian	Granites, Gneiss, shist	-	-

2.24 In the Twin Cities, the Mississippi River is the source of municipal water supply. The 13 surrounding communities all have deep wells in the underlying bedrock aquifers. Total groundwater consumption was 200 mgd (million gallons per day) in 1970, estimated to be about one-fourth the total sustainable yield. The Prairie du Chien-Jordan aquifers supply about 75 percent of this water, while the Mount Simon-Hinckley aquifers supply another 15 percent to the deep wells. The former aquifers supply a medium hard water from 350 to 450-foot depths. It also contains more dissolved solids, sulfates, and bicarbonates, but lower iron and chloride than the lower (1,000-foot) Mount Simon-Hinckley aquifer.

2.25 Water supplies in the Minnesota River drainage basin are derived from sand and gravel deposits in the glacial drift, stream alluvium, and bedrock rock strata. Municipalities generally obtain their water from aquifers in the bedrock. Lenses or beds of sand and gravel in the glacial drift supply a large share of private and farm wells and some municipalities in the uplands. Alluvial sediments in stream valleys are a significant source of water for private and farm use. Some municipalities also derive water supplies from the alluvium. River or surface water is not used as a source due to organic and inorganic contamination and silt content. Impurities and silt content are especially high from Shakopee, Minnesota, downstream to the mouth of the Minnesota River. Compared with bedrock and glacial drift aquifers, the water from the alluvium is very hard and high in iron content.

2.26 In the St. Croix River area, the Prairie du Chien-Jordan aquifers supply groundwater from a regional recharge area located approximately between Forest Lake and Hastings, Minnesota. This groundwater is medium hard and contains more dissolved solids, sulfates, and bicarbonates, but less iron and chloride than the softer water in the Lower Mount Simon-Hinckley aquifer. The Dresback and Mount Simon-Hinckley aquifers rise northward in the basin and help to supply various municipal, private, and farm needs. The ancient Precambrian Keweenawan lava flows and sandstones lying east of the Douglas Fault which trends roughly north-south through Chisago and Pine Counties of Minnesota, supply some of the groundwater needs in the basin. Alluvial sand and gravel deposits in stream valleys are important to private well owners. On the uplands, glacial outwash and lenses of sand and gravel in the glacial till furnish water for a significant number of private, farm, and some municipal wells. Hardness or softness and other chemical or mineral inclusions in the water are dependent on what aquifer is being tapped.

2.27 Although the alluvium in the floodplain of the Mississippi River valley contains adequate supplies of water, all of the larger towns and cities as well as the majority of smaller communities in the floodplain obtain their potable water from the underlying bedrock aquifers, depending on stratigraphic position. The principal aquifers are the Jordan, Dresback

and Hinckley sandstone formations. In the more concentrated population areas the water in the alluvium has been contaminated. Many private wells do obtain water from the alluvium where the water is judged suitable for potable or industrial use.

CLIMATE

2.28 The climate in the Upper Mississippi River basin varies from dry subhumid in the west to humid near Lake Superior, with the Twin Cities of Minneapolis and St. Paul, Minnesota, in the larger, moist subhumid central region. The average temperature varies from about 45 degrees F to less than 40 degrees F from south to north, while the normal total precipitation varies from less than 20 inches per year in the prairie to more than 36 inches per year in the northeast. About 20 percent of this precipitation falls between November and March. This is a generally windy region. Average wind velocities range from 6 to 12 miles per hour with storm winds, especially tornados, greatly exceeding this. Generally the summer winds are southerly, bringing tropical air to the region. Winter winds bring cold Arctic air masses.

2.29 The climate is typically continental because of the lack of proximity to oceans or other large water areas. The climate of the Mississippi River valley downstream from pool 4 is moderated because the floodplain is only about 550 feet above sea level and is flanked by bluffs which rise as high as 650 feet above the valley floor. Winters are less severe, at Winona, Minnesota, for example, than they are in the Rochester, Minnesota, area only about 45 miles to the west.

2.30 The annual average temperature at La Crosse, Wisconsin, in pool 8 has ranged from 41.9 degrees F in 1917 to 51.6 degrees F in 1931. The mean annual average temperature is 46.4 degrees F. The average temperature ranges from a minimum of 6.9 degrees F in January to a maximum of 83.1 degrees F in July. At Winona, the maximum temperature over a 36-year period was 108 degrees F, while the minimum temperature during the same period was -40 degrees F.

2.31 The date of the average last killing frost over a 16-year period at Winona was May 3, while the date of the first average killing frost over the same period was on October 8. The length of the growing season at Winona averages 158 days. Downstream, at Prairie du Chien, Wisconsin, the growing season is 166 days.

2.32 At La Crosse, Wisconsin, most precipitation occurs in June and least precipitation occurs in December, January, and February. The minimum annual precipitation of 16.8 inches occurred in 1910 and the maximum annual precipitation of 42.4 inches occurred in 1938. The mean annual precipitation is 30.9 inches.

2.33 During January, winds at La Crosse, Wisconsin, blow most frequently from the northwest with an average speed of 11 mph. Winds blow most frequently from the northwest in April, also, with an average speed of 14 mph. Southerly winds with an average speed of 8 mph prevail during July. October winds are generally southerly at a speed of about 10 mph.

2.34 The air quality at Minneapolis-St. Paul is generally satisfactory to good according to Minnesota Pollution Control Agency standards. Near pool 3, automobile, fossil fueled power plant, and refinery emissions are occasionally trapped by thermal inversions. Downstream, air quality is generally good. Thermal inversions occur frequently during Indian summer weather in September and October. The inversions are usually of short duration and, since the area is not heavily populated or industrialized, few air pollution problems exist.

SOILS

2.35 The depth to bedrock in the Mississippi River valley varies from exposure at St. Anthony Falls in Minneapolis to over 150 feet at pool 10. The majority of this valley has been backfilled with glacial outwash composed of sands and gravels.

2.36 Soils in the Upper Mississippi River basin vary from the northeastern well-leached soils, which have a shallow organic layer and are typical of moist forests, to poorly leached soils having a deep organic layer in the prairie southwest. Soils in the Minneapolis-St. Paul area vary primarily from sandy clay loams on till to loamy sands. A few small areas of clayey soils are found in the area. Well-drained sites and northern exposures have lighter soils with less organic material.

2.37 In the St. Anthony Falls area, soils along the riverbank are generally sands. On top of the bluffs, soils are generally classified as sandy clays. These soils are characteristically well-drained on hills, but have a high water table in lower areas. The percolation rate is generally less than 10 minutes per inch. These soils tend to be acid and low in nitrate and potassium.

2.38 The soils along and on top of the bluffs in pool 1 are generally medium and coarse sandy soils of variable thickness. In the river valley, dark, organic river-bottom soils seasonally inundated and poorly drained are present only on the river flats below the University of Minnesota and in the lower portion of west Riverside Park. Other low, sandy soils occur as dredged spoil deposits at river miles 849.5, 851, and 852.

2.39 Soils along and on top of the bluffs in pool 2 are generally medium to coarse sandy soils of variable thickness. Along the right bank from

Mendota to Hastings in Dakota County, soils are overlain by 1 to 3 feet of river material. Soils are characteristically well-drained, acid, and low in nitrate and phosphate, with a percolation rate generally less than 10 minutes per inch. A richer clay soil occupies a small stretch along Dayton's Bluff southeastward to Pig's Eye Lake, and has a percolation rate 5 to 15 times slower than the sandy soils. In the river valley, poorly drained, dark organic river bottom soils comprise 10,000 acres of floodplain mostly between Fort Snelling and St. Paul Park. In St. Paul, much of this floodplain is being covered by fill for industrial and commercial development.

2.40 Along the Minnesota River, soils along the bluff top generally are coarse to medium on the left bank from the Red Rock-Staring Lakes area downstream to Fort Snelling and on the right bank terrace at Shakopee, from Savage to the I-35W Bridge, and from the Black Dog power plant to Mendota. These soils are characteristically well-drained, acid, and low in nitrate and phosphate. The percolation rate is generally less than 10 minutes per inch. Medium to moderate fine soils are found on the bluff top and slope upstream from Red Rock Staring Lakes area and along the bluff slope downstream of these lakes to Fort Snelling. On the right bank, these medium to moderate fine soils are found on the bluff top south of the terraces at Shakopee and along the bluff slopes from Scott County Highway 25 to Savage. These rich, clay soils have percolation rates 5 to 15 times slower than that of the sandy soils. Dark, organic soils comprise the 17,600 acres of floodplain found in the lower 30 miles of the Minnesota River valley. Percolation is slow, ranging from virtually zero at saturation to as much as 5 inches per hour when the soils are dry or drained. The pH of these river bottom soils is acid where peat has accumulated and alkaline in the mineral soils.

2.41 The silt or sandy loam soils along the St. Croix River between Taylor's Falls and Stillwater, Minnesota, form a thin cover over the bedrock. There is relatively little floodplain adjacent to Lake St. Croix in the lower portion of the river. From south of Bayport to Afton, Minnesota, there are large, nearly level terraces composed of sand and gravel. There is very little alluvial land along this stretch of the river, but nearly level sand and gravel deltas and alluvial fans have formed at the mouth of almost every tributary stream. Flooding is frequent on these fans and on the adjacent areas of alluvial land. There are several low sandy islands, bars, and peninsulas in the lake that are frequently used for picnicking and other river-oriented recreation. The sandbars are heavily used as beaches by recreational boaters and canoeists. Other low areas are residential or city parks.

2.42 The soils in the pool 3 area vary primarily from sandy clay loams to loamy sands. On the bluff tops, the soils vary in thickness and

quality, generally being medium to coarse sandy. In the floodplain, the soils range from organic river bottom types to sandy, being inundated periodically and generally poorly drained. The very fine silt-load of the Mississippi tends to clog the soils for drainage, leaving many untillable "pot-holes."

2.43 The soils of the floodplain along pools 4, 5, 5A, and 6 are alluvial and vary in texture from silty clay to sand. The composition of the soil depends upon the manner in which the soil was laid down. The strata are composed of clay, silt, sand, and gravel and are very irregular. Stream banks plainly show the varying thickness of the different materials and in many places indicate a lack of continuity of the sand and gravel layers above low water level. Sand and gravel strips border most sloughs, but some of the larger, more elevated areas between the sloughs are covered with heavy silty loam which is underlain with sand or gravel. Prior to impoundment, these silty tracts were usually managed for hay.

2.44 Soils in the area of pools 7 and 8 have been derived from a variety of parent materials. In a few places, particularly on the steep slopes in the Driftless Area and on the escarpments overlooking the Mississippi River, the soils are derived directly from weathering of bedrock materials. In the majority of the watershed, however, the soils are derived from the covering materials. This is most commonly glacial till, but in some areas, alluvium and loess predominate. The weathering of this till has taken place under different vegetative coverings, resulting in several soil types. Podzolic soils consist of loess or alluvial silts, sand, weathered products of sandstone, or red clay. These soils have formed under deciduous trees in a temperate continental climate under a cover of tall grasses. The bog soils are represented in this area by muck and peat. This type of soil predominates on the lower edges of terraces in the river basins. Alluvial soils are formed from material recently deposited in floodplains. The regosols consist of deep soft mineral deposits in which few or no clearly expressed soil characteristics have developed.

2.45 The loess cap lies as a blanket over the other parent soil types. Composed of silt-sized particles, it is uniform in distribution and chemical composition. Whereas one might expect to find different vegetational patterns in the Driftless Area because of exposure and weathering of ancient rocks, the loess cap provides a constant substrate of recent origin for vegetation to develop on, thus obscuring any effect of the original rock type.

2.46 The principal parent materials of soils in the drainage basin associated with pool 9 are loess, alluvium, and glacial drift. Many pockets and fans of glacial outwash, associated with old meltwater channels, formed as ice melted during the most recent Wisconsin glacial period. Meltwater flowed from the margins of the ice sheet and redeposited a partially sorted mixture of gravel, sand, and silt. Many of these meltwater channels are now streams in the glacial till areas

along the Mississippi River. Soils in the pool 9 area developed under forest cover and belong to the gray-brown podzolic soil group. These soils generally occur on gently rolling to steep topography along major streams. The principal soil associations of the pool 9 are the Fayette and Fayette-Dubuque-Stonyland (FDS). The FDS association generally contains a higher percentage of shallow limestone soils on steep, stony land than the Fayette soil association, with the limestone often exposed on the steep slopes. The 1 to 60 degree slopes associated with these soil types make them very susceptible to erosion in upland areas, where vegetal cover is sparse or where adequate soil conservation practices are not carried out. The sediment load carried into pool 9 by its major tributary, the Upper Iowa River, produces significant natural siltation which accumulates in backwater areas and, to some extent, in the navigation channel.

2.47 The major soil type of islands and upland peninsulas in pool 9 is Dorchester silt loam with 0 to 1 percent slope. This soil is light colored, generally lacks a B horizon, and is built up on black buried soil. The texture is sandy in some places and the profile may contain thin layers of sand. The bottomland soils are flooded nearly every year for a short time. Flooding generally occurs during thaws early in spring or after heavy rains prior to the growing season.

2.48 Most of the upland soils in the pool 10 drainage basin were developed from loess. The specific soil type depended upon the vegetation on the loess deposits, and varied from deep rich loam under prairie or maple woodlands to leached podzolic soils under the oak-hickory woodlands. Soils on the steep bluff sides that did not retain the loess cap developed from weathered limestone or sandstone. The north and east slopes, covered with moderately moist maple forests, developed a rich loamy soil. The south and west facing slopes, with "goat prairies" or cedar glades, developed a clay loam which is thin as a result of erosion from runoff from the steep slopes. Some of the high terraces have sandy loam soils which developed under prairie vegetation.

2.49 The bottomlands have diverse soils of alluvial origin. Most of the bottomland soils are composed of layers or lenses of sand, clays, and silts deposited following periodic flooding. In areas of annual flooding, there is little soil development since humus material is removed or covered annually. The higher lands on the natural levees or the terraces may develop an A layer. A gley layer of sticky fine clay with blue-green mottling from reduced iron is present in all bottomland soils. It indicates poor internal drainage and anaerobic soil conditions.

SURFACE WATER

2.50 Introduction - Nearly all surface water runoff in the Upper Mississippi River basin north of Guttenberg, Iowa, is supplied by

precipitation falling within its boundaries. Only minor amounts of runoff are contributed through municipal and industrial withdrawals of water from subsurface aquifers whose sources are outside the basin. The average annual precipitation over the basin is 28.3 inches, 21.0 inches of which return to the atmosphere by means of evaporation and transpiration. The remaining 7.3 inches, an average of 27.6 billion gallons per day, passes out of the basin as surface water runoff via the Mississippi River.

2.51 Monthly distribution of runoff - Runoff varies in accordance with seasonal variations in temperature and precipitation. The months of highest runoff are generally March through June roughly paralleling the monthly precipitation pattern. The average monthly flows then generally taper off, except for an increase in late summer or early fall, reaching minimum values during the winter months. The March and April flows are augmented by the melting of snow which has accumulated during the winter months.

2.52 Annual runoff - Annual runoff, dependent mainly on precipitation, is influenced by temperature, vegetation, terrain, and geology. The annual runoff, as a percentage of the annual precipitation, varies greatly over the basin. The headwaters area of the Minnesota River yields less than 5 percent of the normal annual precipitation to runoff, whereas northern Wisconsin yields up to 40 percent annual precipitation to runoff.

2.53 Floods of record - The flood season for the main stem of the Mississippi River is March through July, and is caused by a combination of melting snow cover and increased precipitation during spring months. The April 1965 flood was the greatest flood of record along a 700-mile stretch of the Mississippi River from Royalton, Minnesota, 100 miles upstream of Minneapolis, to just below Hannibal, Missouri. The peak discharge was 171,000 cfs at St. Paul compared to the previous record of 125,000 cfs in April 1952, with a 4.0-foot increase in stage. Most Minnesota and northern Iowa tributaries were at or near previous record flood stages. The severity of tributary flooding generally diminished toward the south with the decreasing snow cover. In most cases, Wisconsin tributaries were at bank-full stages or slightly above. More recently, the 1969 flood peak at St. Paul also exceeded the 1952 high water but was 1.5 feet less than 1965.

2.54 The 1965 flood was caused by: an early fall freeze that pushed frost deep into the ground before snow had fallen; a February thaw and rain which covered southern Minnesota and northern Iowa with a saturated, frozen, and nearly impermeable ground surface; March snows which were as much as 300 percent of normal in east-central Minnesota; and a late siege of cold weather in March and early April which prevented the gradual runoff of the snowpack. These factors combined with spring rains to cause this socially and economically disastrous flood.

2.55 The five largest recorded flood volumes for sample tributary and main stem stations in the study area are listed in Exhibit 62. The peak discharge is also listed when available. It is apparent that the magnitude of a flood peak is not indicative of the quantity of water in the flood. The severity of a flood is related to both peak and volume, especially as a flood moves downstream. Two floods with equal peaks, but with substantially different volumes, will have different effects downstream. The flood with higher volume will have more water to fill channel storage and, provided that the greater volume is distributed both before and after the peak, will cause a higher stage downstream than the flood with lower volume. The greater volume also increases the chance of two or more tributaries having individual peaks coinciding at their confluence.

2.56 Drought flows - Temperature, wind, land treatment, and distribution of precipitation throughout the seasons are factors which combine in varying degrees to produce droughts. Drought conditions may be said to prevail when either natural vegetation withers or defoliates unseasonably and crops fail to mature owing to lack of precipitation, or precipitation is insufficient to meet the needs of established human activities. In general, there are not serious drought effects unless annual precipitation is less than 85 percent of the mean.

2.57 Drought is among the most potentially destructive extremes of nature. It differs from other climatic catastrophes, not in the severity of its devastation, but in its comparatively slow arrival, its cumulative effects, and the often vast areas of influence. The most severe and widespread low flow drought in the entire basin was during the early 1930s, particularly in 1934. In terms of nationwide precipitation, 1934 was the driest since 1886 when the Weather Bureau first began compiling records on a nationwide basis. Of the seven stations keeping records during that period, the year 1934 had the lowest average flow at five recording stations. Streamflow was less than 50 percent of normal throughout the basin, except in Wisconsin.

2.58 Other periods of drought prevailed in the basin during the last few decades when streamflow gages were sufficiently widespread to record them, but they were neither as general nor as severe as in 1934. The period 1956-59 was a period of greatly deficient flows in northern Iowa, Minnesota and Wisconsin.

2.59 Although streamflow is directly dependent upon precipitation, deficient streamflow is not absolutely correlated to deficient precipitation. Steady, light showers may supply the soil with an adequate moisture supply for crops but will have little excess to maintain streamflow. Conversely, intense, brief rains are absorbed by only the immediate topsoil and most of the moisture is lost to streamflow by surface runoff.

2.60 Minnesota River Pool - A study of the major rivers in the Twin Cities area by the Federal Water Pollution Control Agency (now the Environmental Protection Agency) showed that, in general, water quality decreased downstream from Chaska to the mouth of the Minnesota River (FWPCA, 1966)* Water quality in the lower Minnesota River was similar to that in the Mississippi, except that turbidity and phytoplankton concentration was greater in the Minnesota. At the confluence of these two rivers the Minnesota also has greater numbers of coliform bacteria. Thus, although the water of the Minnesota River is generally of lower quality than the Mississippi at Mile 844, the Minnesota has only a moderate effect except for turbidity because its flow is about 30 percent that of the Mississippi River. Its turbidity and total coliform organisms are about two-fold, however.

2.61 At Mile 27.5 during the summer months, the DO (dissolved oxygen) averaged 9.1 ppm, decreasing abruptly below Shakopee (Mile 25.0) and continuing to decrease to 6.6 ppm (parts per million) at Mile 1.9 (FWPCA, 1966). The oxygen sag or minimum point of 2.7 ppm appeared to be located at Mile 10.8, just downstream from Port Marilyn.

2.62 Also, turbidity increased downstream, averaging 70 JTU (Jackson Turbidity Units) at the lower end. Although turbidity less than 25 JTU was found, as much as 240 units were observed, during and after rainfall.

2.63 Coliform bacterial concentration is markedly increased above that entering this reach of the river by effuents from Rahr Malting Company and the Chaska and Shakopee sewage treatment plants, so that the density at Mile 23.0 ranged from 240,000 to 2,400,000 MPN/l (Most Probable Number per liter). Although Cargill (Mile 13.4) caused an increase by 10,000 MPN/l, coliform bacteria decreased downstream progressively to an average of 137,000 MPN/l at Mile 1.9 due to die-off and dilution.

2.64 During the winter months water quality may decrease due to changes in commercial activity and the weather. When ice covers this segment of the river, gaseous exchange with the air is prevented. Also light is blocked so that photosynthesis, which produces oxygen, does not occur and there is a buildup of CO_2, H_2S, etc.

* Federal Water Pollution Control Federation. 1966. A report on the pollution of the Upper Mississippi River and its major tributaries. U. S. Department of the Interior, Great Lakes Region, Chicago, Illinois, 236 pp.

Thus, the DO averaged 5.0 ppm (35 percent saturation) at mile 29.6, under the ice, and dropped progressively downstream from the now operating American Crystal Sugar Company to 1.4 ppm at Mile 14.3. For several miles below the Black Dog power plant the River is ice free, apparently increasing the DO to an average 3.0 ppm. The DO dropped again to an average 1.8 ppm under the ice by Mile 1.9.

2.65 The use of water from the lower 25-35 miles of the Minnesota River thus is suitable only for cooling water, for navigation, aesthetic enjoyment and pollution-tolerant aquatic life. However, just below the Black Dog power plant in 1964 even the latter may be excluded. The low DO apparently caused a fish kill in the winter of 1964.

2.66 According to the FWPA "most of the turbidity is a result of erosion of the riverbanks and inadequate land practices in the drainage area. Stock watering, sport fishing, and pleasure boating were practiced although the water quality was considered unsuitable." Turbidity in the Minnesota River is nearly 10 times that of the Mississippi River.

2.67 The flow and some water quality parameters of the lower Minnesota River are continuously recorded by the USGS (U. S. Geological Survey) and EPA (Environmental Protection Agency), respectively. The daily mean flows, recorded at the USGS gaging station at Carver, Minnesota, shows that high water may occur in summer and fall as well as spring. The water quality parameters include dissolved oxygen (DO), pH, temperature and specific conductance (an estimate of dissolved solids) and are monitored automatically at Mile 3.5 (where the airport approach lights cross the river). Dissolved oxygen and specific conductance reach a maximum in winter, and DO peaks again in spring. Variations in these data are attributable to variations in flow and temperature, while pH also shows considerable fluctuations but a seasonal pattern is not discernible.

2.68 <u>Upper and Lower St. Anthony Falls</u> - Water quality is considered generally good in the Mississippi River downstream nearly to St. Anthony Falls, especially when compared with the next three downstream pools (FWPCA, 1966). Water use is varied in the Upper Pool, including use by industry, navigation, recreational boating and fishing, and aesthetic enjoyment; the only activity advised against is swimming (whole body contact). Quality decreases just upstream from the Falls, affecting water usage for consumptive use by humans and animals, and limited body contact. Although the dissolved oxygen is high (average of 8 milligrams per liter) bacteria and phytoplankton reach relatively large numbers, some species of the latter sometimes causing taste and odor problems.

2.69 Dissolved oxygen, turbidity, and water temperature were collected in September and November, 1973, along the length of the Mississippi and Minnesota Rivers in the Twin Cities area. Dissolved oxygen in the Mississippi did not vary greatly from concentrations of 6 to 9 ppm from the Minneapolis Water Works to Newport, although there seemed to be a slight increase due to the turbulence of the St. Anthony Falls Lower Dam and the Ford Dam. However, the river "metabolism" is not at its highest during November, thus important differences along the length of the Mississippi may have been missed.

2.70 Turbidity of the Mississippi River varies from 3 to 6 JTU from Fridley to the mouth of the Minnesota River which has a turbidity of 42.5 to 56 JTU. This turbidity results in an increase to a turbidity of 11 to 12 JTU in the Mississippi River downstream from the confluence with the Minnesota.

2.71 Pool 1 - Water use in pool 1, as in adjacent pools, is varied, including supply for industry, navigation and recreation and aesthetic enjoyment by a large metropolitan area.

2.72 Generally water quality is good in pool 1 compared with downstream water quality, except for bacterial levels. During and just after rainfall some or all of numerous storm sewer discharges increase bacteria to levels which create a health hazard. However, water quality throughout pool 1 permits a wider usage than in pool 2, although in 1966 water quality exceeded the maximum level of pollutants for such uses as potable water and swimming and other water contact sports. In 1973, however, swimming was popular at several sites in pool 1. One of the most popular sites was adjacent to the abandoned lock upstream from the Lake Street Bridge.

2.73 Water quality parameters illustrate normal seasonal variation in the Mississippi River in the Twin Cities area. Some variation may occur between Anoka and pool 1 due to industrial storm sewer effluents. This may be especially true of the temperature downstream from the Riverside Power Plant.

2.74 Water temperature, dissolved oxygen, pH and specific conductivity are automatically monitored at the Minneapolis Water Works in Fridley and by the EPA at the Riverside Power Plant. Water temperature ranged from a winter low of about 32 degrees F to a summer high of 85 degrees F. Dissolved oxygen ranged from a low of about 5 mg/l (milligrams per liter) in summer to a high of about 17 mg/l in winter. Generally the DO has two periods of low concentration: during low flows in summer and under the ice in winter. By comparison the DO record at Grey Cloud Island for the same period shows that the DO concentration may reach zero mg/l. Day to day variation also is greater within the Twin Cities.

2.75 Effluents from the Metropolitan Wastewater Treatment Plant, the South St. Paul Sewage Plant, as well as 16 other sources enter pool 2 from the MWTP site downstream to lock and dam 2. These decrease the dissolved oxygen, benthic organisms, and percent of game fish in the total fish population. At the same time, undesirable characteristics increase, such as coliform bacteria and other possible pathogens (FWPCA, 1966). However, water quality throughout pool 2 above the Metropolitan Wastewater Treatment Plant exceeds the maximum limits for such uses as potable water and swimming. Below this plant, further use is restricted to such uses as waste assimilation, and aesthetic enjoyment.

2.76 Daily mean flow is measured at gages in Anoka and St. Paul, while the other data are automatically recorded at the Northern States Power Company's Riverside plant (Mile 856.9) and the Shiely terminal on Upper Grey Cloud Island (Mile 826.6). While in general seasonal patterns are repeated as in other pools, the magnitude and time of occurrence vary from one year to another. There are sometimes considerable differences both in magnitude and time of occurrence between the upstream (Riverside) and pool 2 (Shiely) stations caused by inflow of tributaties, storm sewers and industrial wastes. Variations in these data range from two to fourfold.

2.77 These data, plus continuing efforts to improve water quality, illustrate the difficulty in attempting to characterize the Mississippi River water quality, except in general terms, based on a few sampling stations and one or a few years study. It also points to the obvious benefit of continuous data (automatically monitored) versus single noncontinuous measurements.

2.78 Specific conductivity and pH occasionally show marked fluctuations, but no marked seasonal pattern. The pH value ranged from 6.5 to 8.5 and specific conductance ranged from 200 to 450 micromhos in pool 1. Downstream from pool 1 the water quality decreases considerably due to the turbidity and bacteria brought by the Minnesota River, and to treated sewage and industrial effluents; the sewage comes from 16 plants, the largest of which is the Metropolitan Wastewater Treatment Plant. At the base of lock and dam 1 the turbulence increases the dissolved oxygen content of the river.

2.79 Pool 2 - Water usage in pool 2 is varied since it includes industrial supply, navigation, irrigation and stock watering, waste disposal, and recreation and aesthetic enjoyment by a large metropolitan area. Generally speaking, water quality is good from lock and dam 1 to the outfall of the Metropolitan Wastewater Treatment Plant at Pig's Eye Island, except for the levels of bacteria. During and just after rainfall, some or all of numerous combined sewer discharges increase bacteria to levels which create a possible health hazard (FWPCA, 1966). Data collected

in 1964 by the Federal Water Pollution Control Administration indicated that the main effect of the Minnesota River is to increase the turbidity and total coliform organisms about twofold. The High Bridge power plant temporarily increases the normal river temperature by about 1 degree F.

2.80 St. Croix River - The water quality of Lake St. Croix appears to be better than that of the Mississippi or the Minnesota Rivers. This better quality may be due to less intensive agricultural and urban development in the St. Croix River watershed. For instance, the coliform bacteria ranged from 80 to 9200 MPN/l (most probable number per liter) in the St. Croix. The Mississippi River may have over 100,000 MPN/l (FWPCA, 1966). Recent data show that the dissolved oxygen in the St. Croix varies from 6 to 12 ppm. Turbidity is also less in the St. Croix compared with the Mississippi downstream from the mouth of the Minnesota River: 1 to 11 JTU compared with 35 to 60 JTU. The St. Croix River also has softer water: 50 to 150 ppm alkalinity, whereas the Mississippi River has 100 to 200 ppm and the Minnesota River from 200 to 300 ppm alkalinity.

2.81 Pool 3 - Generally, the water quality as it leaves pool 2 is relatively good. In past years, this has not been true, due to effluent from the Minneapolis/St. Paul Sanitary District (MSSD) which was not always biodegraded by the time the water reached lock and dam 2. In cooperation with the MSSD, the Corps increased the aeration capabilities of dam 2 tainter gates to the extent that the dissolved oxygen of pool 3 seldom drops below the recommended 5 mg/l. In past studies, the waters of pool 3 have been termed grossly polluted (FWPCA, 1966). Subsequent to the report of the FWPCA, the two greatest floods of record, 1965 and 1969, have passed through pool 3. Whether the flushing action of two major floods in rapid succession was responsible for an up-grading of the water quality is not easily assignable. The numbers of macro-invertebrates was down as was the number of species present. Clean water indicating organisms were not in a preponderance, and the BOD was high as were the numbers of pollution-tolerant organisms. The series of studies in 1971, 1972 and 1973 for Northern States Power has demonstrated the recolonization of the Mississippi River substrates by large numbers of caddisflies, mayflies, and some stoneflies as well as many Dipterans. The presence of those which are univoltine species is indicative of "clean waters" at the current time. Miller has termed the area as being a "recovery-zone" after the pollutants from the Twin Cities (Miller, 1971). * The high water quality of the

* Miller, Edward. 1971. Environmental Monitoring and Ecological Studies Program. 1971. Annual Report on Prairie Island Nuclear Generating Plant for Northern States Power Company. 1-207 pp. Published by Northern States Power Company, Minneapolis, Minnesota.

major tributary, the St. Croix River at Prescott, Wisconsin in the upper portion of the pool, has a beneficial effect on the overall water quality of pool 3 waters. The St. Croix juncture with the Mississippi is the terminus of the first "Wild River" of the United States. The water quality is visibly discernable from an aircraft, in that the clearer waters of the St. Croix can be followed downstream into the Mississippi almost a mile after meeting each other.

2.82 The coliform bacterial count remains relatively high, and the Minnesota Board of Public Health still classifies the pool 3 stretch as "whole body contact constitutes a distinct health hazard". Recreational use for water skiing and swimming is widespread downstream of mile 802 of the Corps Navigation Charts.

2.83 Pools 4, 5, 5A, 6 - Except for Lake Pepin and the upper reaches of pool 4, the Mississippi River has generally good water quality throughout pools 4, 5, 5A, and 6. Except in isolated sloughs and backwater lakes, the dissolved oxygen content of the water remains high year round. Because of its turbulent nature, the river is well aerated and it can assimilate a considerable biochemical oxygen demand (BOD) loading. Fertility levels (nitrogen, phosphorus, potassium, calcium, etc.) are ample to support luxuriant growth of rooted aquatics and algae.

2.84 Average phytoplankton densities for the period April-December, 1964 were 18,000 per ml at mile 790.6 and 12,000 per mile at mile 760.2. Phytoplankton densities were usually very high along the shorelines of Lake Pepin. During the summer of 1965, a greenish algae bloom of pea soup consistency was observed in Lake Pepin at the bathing beach in Stockholm, Wisconsin. Decaying algae created an odor which attracted hordes of flies. A water sample from the area revealed 12,511,000 blue-green algae per ml with 12,487,000 being *Aphanizomenon flosaquae* and 24,000 being *Anabaena* sp. Similar observations were made in 1964 and 1965 at Lake City.

2.85 The chlorophyll - a content of plant cells attached to artificial substrates-showed that periphyton was about six times as abundant on such substrates in Lake Pepin as on those located upstream. Nutrient concentrations although more than ample to support luxuriant algae growth, decreased downstream through Lake Pepin.

2.86 Benthic organisms found in the 10-mile segment between lock and dam 3 and the head of Lake Pepin were all pollution tolerant and ranged in density from 46 to 214 animals per square foot during the fall of 1964. Both the number of animals per square foot and the number of kinds of animals increased downstream through Lake Pepin. The first reappearance of pollution sensitive organisms below the Twin Cities' zone of degradation occurred at mile 784.2, the head of Lake Pepin.

2.87 A gelatinous organic sludge bottom, sometimes mixed with organics and silt, covers the bottom of Lake Pepin between mile 784.2 and mile 764.7. This bottom supported a large total number of animals (318 to 903 per square foot during the fall of 1964) made up of from 16 to 20 species. Aquatic annelid populations exceeded 100 per square foot at all stations, indicating an organic relatively anaerobic environment. Tendipes midges were also very abundant. They, too, indicated that Lake Pepin acts as a natural settling basin for silt and organic sludges carried in from upstream. Pollution sensitive species, such as unionid clams, mayflies, caddisflies, and riffle beetles, represented less than 50% of the total species and were found only in sandy shoreline areas. Even at the lower end of Lake Pepin (mile 764.7) the total numbers and species of pollution-sensitive animals was far less than in the area upstream from the Twin Cities. Lake Pepin is obviously still within, but near the end of a pollution recovery zone.

2.88 A series of transects was established throughout the study area during the spring and summer of 1973.

2.89 Water quality measurements were made at various sites. The parameters included temperature, pH, Secchi disk transparency, dissolved oxygen, total hardness, calcium hardness, alkalinity, nitrate, ammonium nitrogen, organic phosphate, inorganic phosphate, ortho phosphate and total phosphate. The various parameters are included as follows:

Pool	4	4	4	4	5	5	5A	6	6
Mile	789	785	774	763	753	739	733	726	715
Temp. Degree C.	29.1	26.1	26.1	23.3	26.1	23.3	23.3	23.3	26.7
pH	8.25	9.0	9.25	9.0	8.0	8.75	8.5	9.0	9.0
Secci Disk (in.)	19	28.5	32	31	24	17	22	20	22
Dissolved oxygen (ppm)	12.5	11	10.5	10	11	11	11	11	11
Total Hardness (ppm)	238	238	187	153	238	238	238	187	238
Calcium Hardness (ppm)	119	102	153	119	102	136	85	85	85
Alkalinity (ppm)	187	187	153	153	153	153	170	140	153
Nitrate (ppm)	0.4	0.2	0.3	0.3	0.2	0.3	0.1	0.2	0.2
Ammonium nitrate (ppm)	0.7	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4
Phosphate									
Organic (ppm)	0.68	0.58	0.7	0.7	0.65	0.6	0.5	1.4	0.67
Inorganic (ppm)	0.50	0.3	0.55	0.58	0.41	0.4	0.5	0.6	0.6
Ortho-(ppm)	0.46	0.3	0.36	0.43	0.35	0.31	0.47	0.45	0.43
Total	1.18	0.88	1.25	1.3	1.06	1.03	1.04	1.96	1.28

2.90 It is apparent from the data that the study area affords a rich and varied invertebrate fauna. The most productive areas are: (1) silted bottoms which are well-oxygenated by flowing water, and (2) the rock rubble which composes wing dams and shoreline protection. The latter substrate provides a great surface area. It, like the silt bottom, however, is productive only as long as it is bathed by oxygen-rich water. The most barren substrate is sand. The sandy bottom of the navigation channel is especially unproductive. Other relatively unproductive areas include the bottoms of thermally stratified floodplain lakes, the depths of which usually become anaerobic during the summer.

2.91 The water chemistry measurements reveal that the river throughout the study area is very fertile and that it is capable of supporting large populations of algae, rooted aquatic plants, invertebrate animals and fish. It must be remembered, however, that such a fertile body of water contributed large volumes of organic sediment to the backwaters. The organic sediment has a high biochemical oxygen demand and it can cause conditions of oxygen depletion at the mud-water interface and in the hypolimnion of thermally stratified floodplain sloughs which have been stagnated by barrier islands of dredge spoil. Furthermore, the organic sediment decomposes very slowly under anaerobic conditions.

2.92 Pool 7 - Since most of the watershed of the Upper Mississippi River is forested, and the geological features in the uppermost portion of the watershed are extremely old Cambrial formations the water in this part of the river is quite soft. Total hardness rarely exceeds 175 mg/l in pool 7 and does only where emergent ground water is concentrated in the pool. The alkalinity of the water varies slightly around 175 meq/l $CaCO_3$, and the water has a characteristic brown color, from organic substances leached from forest flood areas. Aeration processes maintain the dissolved oxygen in excess of 60% saturation at all times. Whereas the water is not well buffered, the pH seldom varies from 7.5-7.8.

2.93 The water received from the Black River is essentially the same as Upper Mississippi River water except that the color is more pronounced. This is because the Black River derives much of its water from the boggy areas in the old, lowest portions of the geological Lake Wisconsin basin, which is rich in soluble organic material. A small percentage of the water in pool 7 is derived from ground water emerging in the immediate vicinity. This water flows through limestone and sandstone aquifers and differs considerably from the surface derived water in the river. It is extremely hard (250-300 mg/l total hardness) and is well buffered (alkalinity= 190-260 meq/l $CaCO_3$). This probably represents an insignificant addition to the water flow through the pool due to the large dilution with surface derived water. The turbidity of the water is quite low during most parts of the year (0-18 JTU). However during periods of high flow the turbidities increase considerably to a range of from 20-60 JTU.

2.94 Pool 8 - Total hardness rarely exceeds 175 mg/l in pool 8 and does only where emergent ground water of local origin is concentrated in the

pool. The alkalinity of the water varies slightly around 175 mg/l and the water has a characteristic brown color from the dissolved organic substances leached from forest floor areas. Aeration processes maintain the dissolved oxygen in excess of 60% during all parts of the year. Since the water is not well buffered, the pH remains slightly alkaline during most of the year. The water received from the Root River is similar in natural quality to the Mississippi River water. However, the Root River, because of the topography of its watershed, is subject to rapid changes in discharge. When discharge is above normal, this river carries extremely high silt and clay loads. Data collected during the spring of 1973 indicate that the turbidity of the Root River was in excess of ten times that in the Mississippi River.

2.95 The La Crosse River has its confluence within the city limits of La Crosse, Wisconsin. It has a relatively small but heavily populated watershed. Because the La Crosse River has three artificial impoundments in its upstream reaches, during normal water discharge periods, the turbidity of its water is relatively low. During flood periods, however, because of the heavy land use in the watershed, the La Crosse River discharges large quantities of silt and clay into the Mississippi River.

2.96 The water entering the upstream end of pool 8 received approximately 15 million gallons per day of sewage effluent from the La Crosse Municipal waste treatment plant . Until 1972, the city of La Crosse operated a primary settling waste treatment facility with a relatively low efficiency. However, a newly constructed activated sludge system is now on line; it discharges approximately the same volume of adequately treated sewage. The material is discharged directly into the main channel at river mile 694, and it diffuses directly into the main body of pool 8. Additional effluents enter the pool from diffused sources such as seepage from septic systems located along the shoreline.

2.97 Pool 9 - The chemical parameters of water quality of pool 9, as reflected from sampling in the main channel at the Dairyland Power Station at Genoa, suggests that the water is of relatively high quality. The discharge water from this power plant appears to be within the Iowa and Wisconsin standards for chemical effluents.

2.98 Cooling water for the main condenser of the Dairyland Power Station at Genoa (referred to as the La Crosse Boiling Water Reactor, or LACBWR) is withdrawn from the Mississippi River. The total transit time for the LACBWR cooling water from intake to discharge is 2.14 minutes. The heated water enters the Mississippi River as a surface discharge and flows into Thief Slough. The cooling water from the LACBWR is discharged at the rate of 71 or 142 cfs depending on whether one or two pumps are in operation. The increase in temperature of the effluent at full power compared to temperatures of intake water, ranges from 11 to 33 degrees F, with higher temperatures

for winter months resulting from recirculation of discharge water to deice the intake structure.

2.99 Section 3-A-1 of Water Quality Standards for Wisconsin applies to surface waters where fish reproduction is of primary importance. For waters of this type, temperatures are not to exceed 84 degrees F, and temperatures are not to exceed ambient temperature by more than 5 degrees F outside a "zone of mixing." Section 3-B-1 of the standards, applicable to surface waters where fishing is desirable in conjunction with other uses, stipulates that temperatures shall not exceed 90 degrees F and temperatures outside the zone of mixing also shall not be elevated in excess of 5 degrees F.

2.100 The waters of the Mississippi River in the Genoa area of pool 9 have been classified by Wisconsin DNR water quality personnel as an interstate water. Assuming that the mixing zone is defined as Thief Slough to the lower end of Island 126, the combined discharge from the LACBWR and Genoa 3 is within even the more stringent standard.

2.101 The heated effluent is not detectable in the Iowa section of the Mississippi River during the warm months. In winter, it elevates the temperature sufficiently to keep the river ice-free for some distance below the Iowa boundary, 4.5 miles south of the plant. However, an increase of a fraction of a degree above freezing is sufficient to prevent the formation of ice.

2.102 Biologists familiar with the Genoa area indicate that fishing in the upper portion of Thief Slough has improved for winter months. This is attributed to the heated effluents from the LACBWR. Plant operations have apparently had no adverse affects on commercial fishing in pool 9.

2.103 The data collected on water chemistry during 1973 indicated that values for the turbidity and total solids of the Upper Iowa River were always higher than for the main channel of the Mississippi River. This was most noticeable after a heavy rainfall, like that occurring in the Upper Iowa watershed on 17 June 1973. Samples from the lower channelized portion of the Upper Iowa on 19 June 1973 had turbidity readings as high as 180 JTU's and total solids as high as 1548 mg/l. Samples from the main channel of the Mississippi River had values which did not exceed 38 JTU's of turbidity and did not exceed 312 mg/l total solids.

2.104 Bacterial analysis reflected the fact that the Upper Iowa River drains agricultural land. Bacterial counts were generally much higher in this tributary than from the Mississippi River itself.

2.105 The analysis of waters entering Big Lake showed that the mean turbidity values, and total solids, were higher than waters at the outlets of Big Lake. Further sampling is needed to determine vertical differences in solids for entering and exiting sloughs. Once this is established it should be possible to get a better picture of the sedimentation rate.

2.106 There was evidence that in some of the backwater habitats there was a temporary thermal stratification with low dissolved oxygen values in the bottom waters. For example, at one site the 14 June water depth was 3 feet. Surface temperature (about 2 p.m.) was 30 degrees C and the dissolved oxygen was 14 mg/l. At a depth of 2.5 feet the temperature was 20 degrees C, and the dissolved oxygen was 6 mg/l.

2.107 Pool 10 - General water quality parameters of pool 10 were similar to those of pool 9. Zooplankton populations ranged from 29,000 per cu. meter to 17, 966 per cu. meter of Copepoda and 267 per cu. meter to 80 per cu. meter of Cladocera. These values were only exceeded by the populations in Lake Pepin.

2.108 While this study was extremely short term it seems to indicate that the reach of the river now included in pool 10 was a transition zone between the upper and lower regions of the river above Lake Keokuk. Further work will have to be done to evaluate if this has been changed with the advent of the 9-foot channel.

SEDIMENTATION

2.109 General - Sediment-related problems are a major concern in the St. Paul District's portion of the Upper Mississippi River basin. Sand and gravel deposited on agricultural land by floodwaters can cause severe loss of soil productivity, possibly requiring expensive treatment to return the land to full productivity. Sedimentation may make drainage ditches difficult and costly to maintain. In some cases, farm lands and urban areas are subject to more frequent flooding because of channel filling. Turbidity and sediment deposits can cause a loss of beach or water-based recreational values. Sediment adds to the cost of treating public or industrial water supplies. Additional storage must be provided in reservoirs for anticipated sediment deposition.

2.110 This Environmental Impact Statement is focusing attention on sediment problems related to the 9-foot navigation system of the Upper Mississippi River and tributaries. Sediment deposition within the navigation channel itself requires dredging within the St. Paul District of over 1.8 million cubic yards of material annually at a cost of nearly $1 million dollars. Dredging is also costly in terms of possible adverse environmental, social, and ecological impacts from turbidity, burial of aquatic or terrestrial vegetation, isolation of backwater areas, interference with recreational craft, and deterioration of riverine aesthetics. Similar adverse impacts also result from naturally occurring sediment deposition unrelated to dredging operations.

2.111 Sediment sources - Weathering, erosion and transportation of materials by water, wind, and other natural processes, over millions of years, shape the surface of the earth. Sediment results from natural processes of weathering and erosion of the rock which forms the earth's crust. Rock, when exposed to water and air, is

disintegrated and fragmented by chemical weathering, including oxidation, carbonation, and hydration, and by the forces of physical weathering from temperature changes, frost wedging, root action, grinding, and impact. Weathering is a slow but continuing process which gradually reduces the rock to small fragments or particles. Erosion occurs when particles are removed by gravity, wind, or water. This Environmental Impact Statement focuses on alluvial sediments which are derived from upland soils and, to a lesser extent, from fluvial deposits and softer rocks, such as sandstone.

2.112 Land erosion by water can be divided into two general processes, sheet or upland erosion and channel erosion. Sheet or upland erosion implies the removal of an approximately uniform depth of soil due to the combined actions of impacting raindrops, which loosen soil particles, and overland flow, which both loosens and transports soil particles. Rill erosion is also included in this category if the rills can be smoothed out by normal cultivation.

2.113 The rate of sheet erosion depends on many factors, including the amount and intensity of rainfall, slope length and steepness, vegetative cover, soil type, and land management practices. Typically, soil loss rates in the Upper Mississippi River basin are highest in early spring after the snow cover has melted and the ground has thawed, but before the protective vegetal cover has been reestablished. The Upper Mississippi River Comprehensive Basin Study (UMRCBS) notes that annual soil losses from sheet erosion as high as 32,000 tons per square mile have been measured.

2.114 By definition, channel erosion implies removal of material from within and along well-defined channels which may carry water continuously or intermittently. This includes gully, streambank, and streambed erosion. Channel erosion, in the form of gullies, can develop very rapidly when land is denuded of its vegetal cover, as with highway construction, urban development, improperly harvested forest areas, and poorly farmed agricultural land. Large quantities of sediment may be eroded in a relatively short time, increasing the sediment load of recipient streams severalfold. Although the erosion itself may last only a short period of time, effects from the resulting slug of sediment may persist for several years before the material is transported through the drainage network. Annual gully erosion has been measured as high as 260,000 tons per square mile.

2.115 Channel erosion is particularly severe during periods of high streamflow when streambank undercutting and sloughing and streambed scour is active. In the study area, highest flows usually occur following spring snowmelt, although high discharges can also result from prolonged or intense rainfall.

2.116 Sediment yields - The Upper Mississippi River basin lying within the St. Paul District has been divided into two generally dis-

similar regions on the basis of agriculturally significant characteristics, including land uses, topography, climate, water, vegetal cover, and soils. Since these characteristics are also principal factors in determining the production of sediment, these two regions represent two rather distinct sediment yield areas.

2.117 The northern and eastern 55 percent of the study area comprises the "Northern Lake States Forest and Forage Region." A large part of this region is forested, with lumbering and recreation the principal land uses. The average annual precipitation from west to east varies from 20 to 36 inches. The average annual temperature ranges from 35 degrees F in the north to 45 degrees F in the south. Good vegetal cover as well as many lakes, swamps, and bogs make this a low sediment yield region.

2.118 The southern and western 45 percent of the study area lies in the "Central Feed Grains and Livestock Region." This region, as its name implies, is largely devoted to agricultural land uses. Topography ranges from nearly level, with small lakes and potholes, to dissected plain, with rolling narrow ridgetops and hilly to steep ridge slopes and valley sides. Annual precipitation varies from 20 to 32 inches going going from northwest to southeast. The average annual temperatures range from 42 to 47 degrees F. This region has a relatively high sediment yield due to a combination of erodable soil, agricultural uses and topography.

2.119 Sediment yields in the Upper Mississippi River basin are relatively low in the headwater areas to the north and east, increasing progressively toward the southern and downstream end of the study area as shown by the sediment isograms in Exhibit 63. This figure, adopted from the Upper Mississippi River Comprehensive Basin Study, gives the annual sediment yield in tons per square mile which might be expected from a 100 square mile drainage.

2.120 Sediment yields for drainage areas of other sizes can be estimated by multiplying the yields from Exhibit 63 by the ratios shown in Exhibit 64. As this latter figure illustrates, the amount of sediment contributed by a large drainage area is generally less per square mile than that from a small drainage area. This is due to several factors. The chances of an intense storm covering an entire watershed diminish as the watershed gets larger and larger. That portion of a basin which is steeply sloped or which has other characteristics of a high sediment yield area decreases as the basin gets larger.

2.121 <u>Sediment movement</u> - Sediment is transported by water as suspended load or as bedload. The suspended load consists of fine-sized particles, such as clay, silt, and fine sand, held in suspension by the turbulence of the flowing water or by colloidal

suspension. Bedload consists of coarser particles which roll, slide, or bounce along the streambed.

2.122 Generally speaking, sheet erosion is the primary source of fine materials which comprise the suspended load, while channel erosion contributes coarser particles which make up the bedload. The major source of sediment is sheet erosion. Consequently, the suspended load is considerably larger than the bedload. The bedload carried by streams in the Upper Mississippi River basin varies between 0 and 40 percent of the total sediment being transported, generally being about 10 percent.

2.123 The present sediment situation in the Upper Mississippi River basin probably reflects a combination of natural and man-induced influences. Erosion and sedimentation, which have been greatly affected by drastic land use changes of the past century or so, are also reacting to more recent factors, including development and maintenance of the navigation system on the Mississippi River and institution of conservation practices in tributary watersheds.

2.124 If the equilibrium of a stream is disturbed by factors affecting its flow, slope, and sediment load, such as structures within the floodway or changes in sediment influx, the sediment-carrying capacity of the stream will be affected. The works associated with the 9-foot navigation channel are examples of disturbances which have affected the natural regime of the Mississippi River. The locks and dams have reduced the sediment-carrying capacity of the river by decreasing its velocity. This has contributed to increased deposition in the floodplain, particularly of finer sediments which may have remained in suspension prior to the 9-foot project, but which now are likely to precipitate out in the quiet backwater areas of the pools.

2.125 In contrast, the wing dams and closing dams were designed to increase sediment-carrying capacity by raising the quantity and velocity of flow in the main channel. This was intended to promote scour within the navigation channel and, thus, reduce the need for dredging. Subsequent sedimentation between and behind the wing dams and closing dams by both natural means and from dredge disposal has increased the effectiveness of these structures. This has contributed to making the river more efficient as evidenced by a slight decrease in water surface profiles.

2.126 Another example of man's activities altering what was probably a near-equilibrium condition is the tremendous increase in sediment load which resulted from careless agricultural and land-use practices and streambank disturbances caused by early settlers and developers in the Upper Mississippi River basin. Gullies, streams, and rivers within the basin adapted to the need for a greater sediment-carrying capacity by adjusting physical parameters, including widths, depths,

and slopes. For instance, it is known that stream gradients steepened, as evidenced by aggradation of streambeds by as much as several feet in their upper reaches.

2.127 Bedload movement - Attention in this Environmental Impact Statement focuses primarily on the bedload, which comprises the major portion of the material requiring maintenance dredging. Under normal flow conditions, velocities in the main channel of the Mississippi River are high enough to keep fine materials in suspension, preventing their deposition within the navigation channel. In contrast, coarse material being transported as bedload tends to shoal in certain reaches of the channel, depending on the quantity and physical characteristics of the bed material and on local streamflow energy and hydraulic factors related to meanders, wing dams, sloughs, and so on. Where areas of deposition intersect with the 9-foot navigation channel, periodic dredging is necessary.

2.128 During non-flood periods, water entering relatively slow-flowing backwater areas off the main channel will likely lose most of its sediment load, which normally consists of fine-grained material only. Generally speaking, coarse-grained material remains almost entirely within the main channel, although velocities under flood conditions may be great enough to put sediment into temporary suspension by saltation. This "saltation load" consists of particles coarse enough to be transported as bedload by normal flows, but fine enough to be put into temporary suspension by turbulence generated, for example, by flood flows. Any of these particles brought into a backwater area generally will penetrate only a short distance before settling out. Fine-grained suspended sediments are carried deeper into the backwater areas, but, if velocities continue to decrease, even these particles may begin to precipitate out until only the finest "wash load" remains in suspension. Some exceptions exist, such as Pomme De Terre (Belvidere) Slough in pool 5, which was a major channel capable of handling even steamboat traffic before the present navigation system was developed. During floods, this slough apparently carries a substantial flow, which brings a large amount of sediment, including coarse sand, deep into the backwater areas.

2.129 Enormous quantities of sediment are transported during floods on the Upper Mississippi River, a time when flow patterns change completely. The dams on the 9-foot navigation system are opened wide and "open-river" conditions prevail. Whereas under normal flow conditions, it is unlikely that a significant amount of coarse material is able to traverse the navigation pools, during the relatively brief periods of flooding, considerable quantities of coarse material may be carried through the pools. Backwater areas also receive substantially greater and faster flows than normal, resulting in deeper penetration and considerably more deposition of sediment.

2.130 Sedimentation and dredging in the navigation pools - A pool-by-pool sediment balance analysis was conducted utilizing the sediment yield data and trap efficiency procedure presented in the Upper Mississippi River Comprehensive Basin Study. Adjustments to the sediment yield data were made where more recent information had become available. Although several interesting items are quantified by this analysis, the results should be considered approximate in light of the rather general nature of the basic sediment yield data and due to limitations in trap efficiency accuracy, particularly with reservoirs as shallow and with as little storage as the navigation pools.

2.131 The sediment entering each pool was estimated by adding the sediment passing through the pool just upstream to that contributed by the area draining directly into the pool being investigated. The trap efficiency for each pool was estimated from Exhibit 65 and applied to the total incoming sediment to determine the amount of sediment trapped by the pool and, conversely, the amount passing through to the next pool.

2.132 Exhibit 66 presents the results of this analysis. The annual quantity of dredging is also shown for purposes of comparison. Several interesting items as well as some of the deficiencies in the method emerged during the analysis. For instance:

a. More dredging is done in Upper and Lower St. Anthony Falls pools and in pool 1 than would be expected using the trap efficiency method. A similar situation is found in pool 4 (below Lake Pepin) and pool 5A. This discrepancy appears to be due to an inaccuracy in the lower end of the trap efficiency curve when applied to the shallow navigation pools, and to sources of bedload sediment not accounted for in the UMRCBS method such as scour below locks and dams, other river bottom or bank erosion related to the presence of the 9-foot channel, locally severe erosion due to construction along riverbanks, and dredge spoil washing back into the navigation channel. Figures in the table have been adjusted to account for these errors.

b. Pools 2 and 3 and Lake Pepin serve as effective traps for most of the sediment reaching the Mississippi River above Lake Pepin. It is estimated that only about 11 percent of the total amount of sediment entering these pools reaches the outlet of Lake Pepin. This material must be very fine "wash load" suspended sediment, which should cause little or no problems in the navigation channel or backwater areas further downstream.

c. The Chippewa River is the source of a large amount of coarse sediment, which contributes to dredging requirements as far downstream as pool 5A. The Chippewa River is responsible for about 20 percent of all maintenance dredging along the Mississippi River within the St. Paul District. About 93 percent of the total sediment yield of the

Chippewa River basin comes from the reach below Eau Claire, Wisconsin, which includes only 17 percent of the drainage area. The primary source of coarse sediment apparently is from bank erosion along this reach. If measures are taken to protect these banks from erosion, the dredging in pools 4 (below Lake Pepin), 5, and 5A, might eventually be reduced by an average of about 35 percent.

d. It was noted earlier that it has been estimated that the bedload of streams in the Upper Mississippi River basin varies from 0 to 40 percent of the total sediment, generally being about 10 percent. If the Mississippi River is assumed to be in near-equilibrium with the present rate of incoming sediment and maintenance operations for the navigation channel, the amount of material dredged should be equal to the amount of incoming bed material less the amount lost to backwater areas or passed on to the next pool downstream. Exhibit 66 indicates that the amount dredged varied from 2 to 38 percent of the total incoming sediment, with a weighted average of 7 percent. These percentages compare very favorably with what would be expected.

2.133 Geographical analysis of Chippewa River - The sedimentation situation as it relates to the Chippewa River is of particular interest because of its readily apparent impacts on the Mississippi River, including the 9-foot channel. The Chippewa River, by virtue of its comparatively steep gradient and high velocity, is superior in bedload-transport capability to the Mississippi River into which it carries several hundred thousand cubic yards of coarse material each year. Consequently, the Mississippi River has had to adjust certain parameters to improve its sediment transport capacity. Lake Pepin is the very evident result of a slope adjustment by the Mississippi River. Coarse material accumulated at the mouth of the Chippewa River due to the inability of the Mississippi River to carry it downstream. As the bed of the Mississippi River continued to aggrade, water ponded behind this natural dam, forming Lake Pepin.

2.134 Width and depth adjustments also occurred in the reach below the confluence with the Chippewa River, culminating in a braided configuration characteristic of aggrading streams transporting large quantities of bedload sediments. This configuration has been largely obliterated by wing dams and closing dams designed to provide a stable and sufficiently deep channel for navigation purposes. Dredging records still show that, except in the immediate vicinity of the mouth of the Chippewa River, very little dredging is necessary in the reach between the confluence of the two rivers and a point just downstream of Wabasha, Minnesota, a distance of nearly 3 miles. In this reach the Mississippi River, aided by the numerous wing and closing dams, has retained the capability of carrying most of the bedload supplied by the Chippewa River. Below this reach, the river widens, velocities drop, and the ability of the Mississippi River to transport coarse material declines as evidenced by a frequent need for dredging.

2.135 Textural and petrologic comparisons were made of material collected from pools 4, 5, 5A, and 6, and from the major tributaries below Lake Pepin, namely the Chippewa, Zumbro, and Trempealeau Rivers, to try to determine the primary source of the bedload material being dredged in these pools. These investigations suggest that effects from the Chippewa River bedload extend downstream through the lower end of pool 4 to include pools 5, 5A, and possibly, 6. This conflicts somewhat with results from the trap efficiency analysis discussed earlier, which indicated that it was unlikely that coarse material from the Chippewa River traveled beyond pool 5A.

2.136 Lake Pepin was sampled and found to contain fine mud throughout much of its length. Therefore, Lake Pepin was not texturally studied in detail. Twelve samples were taken from the main channel in pool 4, two from above Lake Pepin and ten downstream from Lake Pepin below the Chippewa River delta. Four, five, and six samples were taken from the main channel and dredge spoil sites in pools 5, 5A, and 6, respectively. Samples were also collected within the mouths of the Chippewa, Zumbro, and Trempealeau Rivers. Sieve analysis results for selected samples are shown in Exhibits 67 and 68. Care should be exercised in interpreting these results, since the data are based on point samples, and sieve analyses of additional samples could yield results varying considerably from those shown.

2.137 Exhibit 69 shows gradation curves based on the average gradation of the samples taken from each pool and tributary. Some useful graphical statistics can be determined from these curves, including mean particle diameter and standard deviation in phi (Ø) units. Phi units are dimensionless numbers used for computational purposes in sedimentology. The standard deviation is a good measure of sorting and is used to derive a verbal classification for sorting. This classification is based on sediment composed of uniformly-sized grains being termed well-sorted, whereas sediment with a wide range of grain sizes would be termed poorly sorted. Generally speaking, the greater the distance of bedload transport, the finer the texture, i.e., the size and shape of individual grains, and the better the sorting. Grain shape was also identified for most samples by visual examination with a binocular microscope. Exhibit 70 presents the results of the graphical analysis and visual examination.

2.138 Exhibit 71 tabulates data from a separate gradation analysis done by Corps of Engineers personnel in the fall of 1973. Samples were taken from selected dredge spoil sites along the Mississippi River from pool 4 (below Lake Pepin) through pool 10. At each site, a sample was taken from the top, middle, and toe of the spoil site. A direct comparison of these results with those presented in Exhibits 67 - 68 should not be attempted because of different sample locations and sampling and testing procedures.

2.139 The bedload sediment in pools above Lake Pepin is derived from sediment sources along tributaries such as the Mississippi River above Minneapolis, the Minnesota River, and the St. Croix River. Pool 4 above Lake Pepin, for example, contains shale fragments which could only have come from southwestern Minnesota, in the Minnesota River drainage basin.

2.140 Lake Pepin has no measurable current and, thus, for all practical purposes, is a true lake. The Mississippi River deposits its bedload at the head of Lake Pepin and forms a delta into the lake. All bedload and a substantial part of the suspended load is trapped in Lake Pepin because of the absence of any appreciable current in the lake. Virtually all bedload sediment downstream from Lake Pepin must then be derived from tributaries below the lake.

2.141 The main tributaries in pools 4 (below Lake Pepin), 5, 5A, and 6 are the Chippewa, Whitewater, Zumbro, and Trempealeau Rivers. The Whitewater and Zumbro Rivers are tributary to pool 5. The Whitewater River deposits its bedload and some of its suspended load in the quiet waters of Weaver Bottoms. The Zumbro River carries its sediment load directly into the main channel of the Mississippi River. However, most of its sediment is easily transported by the Mississippi River as evidenced by the lack of a delta at the mouth of the Zumbro River. The texture of Trempealeau River sediment is similar to that of the Mississippi and Chippewa Rivers. However, since it discharges into the quiet waters of Trempealeau Bay, only a fraction of the Trempealeau River bedload may be able to reach the main channel of the Mississippi River. Consequently, the Chippewa River appears to be the major source of bedload materials in the pools immediately downstream of Lake Pepin, possibly including pool 6.

2.142 Qualitatively, the textural analysis of pool and tributary samples seems to support this contention. There is a general similarity between Chippewa and Mississippi River sediments. The mean particle diameter of Mississippi River material is slightly less and there is a trend toward a smaller standard deviation, both of which could be attributed to normal grain abrasion and sorting during sediment transportation. However, Exhibit 69 seems to indicate that pool 6 sediment may more closely resemble that of the Trempealeau River rather than that of the Chippewa River or pools 4, 5, and 5A. Therefore, the degree of influence of the Chippewa River in pool 6 remains doubtful.

2.143 Petrologic examination of the coarse-sand fraction of samples from the Chippewa, Mississippi, and Zumbro Rivers also indicates that the Chippewa is the main tributary source of bedload for this portion of the Mississippi River. Sand grains were classified into rock types by visual examination with a binocular microscope. Grains were separated into rock types including: igneous and metamorphis,

quartz, carbonate and sandstone, shale, and miscellaneous. The results are tabulated in Exhibit 72. The location of each sample is the same as the corresponding samples in Exhibits 67 and 68.

2.144 The bedload samples from the pools have a relatively high percentage of igneous-metamorphic grain content compared to Zumbro River bedload. Pool bedloads are generally petrologically similar to the sample from the Chippewa River. The occurrence of Lake Superior agate, which is characteristic of the Superior Upland Province, and iron-oxide-coated grains in pool bedload sediments also suggests that the sediment is derived primarily from the Chippewa River, since only the Chippewa has these two distinctive types of grains as part of its bedload. The iron-coated grains appear as shiny, metallic gray particles that can be easily recognized in the many spoil sites throughout these pools.

2.145 The Chippewa River acquires most of its bedload sediment from glacial terraces and easily eroded sandstones. Based on field and petrologic studies of the sediment, the terraces appear to be contributing most sediment to the river. Dams on the Chippewa River at Eau Claire and Chippewa Falls prevent significant quantities of bedload sediment from reaching the river below Eau Claire. Thus, most of the bedload sediment reaching the Mississippi River must come from that stretch of the Chippewa River from Eau Claire to the junction with the Mississippi River. This stretch of the Chippewa River has many terraces composed of sand and gravel. The terraces are up to 100 feet high and are subject to undercutting by the river. Exhibit 73 shows the Chippewa River in contact with the face of a glacial terrace a short distance upstream from Durand, Wisconsin. The terrace face is very steep and is continually being eroded by the river. A sample taken from the terrace shown in Exhibit 74 contained slightly more than 3 percent iron-coated pebbles. As shown in Exhibit 72, the relative proportions of igneous and metamorphic grains compared to quartz grains is similar to samples taken from the Chippewa and Mississippi Rivers.

2.146 <u>Chippewa River bedload quantities</u> - The computation of suspended sediment yield from streams has been done for years by the U.S. Geological Survey. Generally, suspended sediment samples are taken to determine the suspended load and particle size distribution. Sediment concentration data and water discharge records can then be used to derive suspended sediment yields on a yearly basis, for instance.

2.147 No satisfactory method exists for routinely measuring the bedload of a stream. Many analytical and empirical bedload formulas have been developed, none of which gives consistently reliable results under natural conditions. Several methods were used in this study

to estimate the amount of bedload contributed by the Chippewa River. Results varied from a low of about 108,000 tons/year to a high of 3,500,000 tons/year. The low figure appears much too small when compared to the dredging records for the Mississippi River below the mouth of the Chippewa River. Similarly, the high figure appears to be much too large when compared to both dredging records and sediment yield data for the Chippewa River basin. Thus, based on available data, extreme values were discarded and remaining figures averaged. The result was an estimate of about 422,000 tons of bedload materials per year, with a range from about 350,000 to 550,000 tons/year.

2.148 In May of 1965, the Corps of Engineers DREDGE WILLIAM A. THOMPSON dredged 314,000 cubic yards of material from the bed of the Chippewa River about 3,000 feet upstream from its mouth. A hydrographic survey made in the spring of 1966 indicated that the dredge cut had been completely refilled. The dredged material had been replaced by normal bedload transport in combination with the more localized movement of bed material caused by the disturbance to the river's natural thalweg. Therefore, the amount of bedload carried by the Chippewa River this particular year may have been less than 314,000 cubic yards. Conversely, since the actual time taken to replace the dredged material may have been considerably less than the time between hydrographic surveys, the bedload transported by the Chippewa River may have exceeded 314,000 cubic yards. Since discharges on the Chippewa River were neither exceptionally high nor low during this period, it would appear that the bedload movement was probably not unusually high or low. When an estimate of 1.35 tons/cubic yard is applied to the dredged volume, the resulting figure is 424,000 tons.

2.149 <u>Trends</u> - Exhibit 75 shows cumulative annual quantity dredged within the St. Paul District versus cumulative annual discharge for the Mississippi River at McGregor, Iowa, in pool 10. The slope of the line progressively decreases from the time the pools were put into operation in the late 1930s until the 1950s. This indicates a distinct trend toward less dredging in relation to river discharge. Since the 1950s, the slope of the line and thus the amount of dredging per unit discharge has remained relatively constant, except for an interruption in slope constancy in the late 1950s and early 1960s.

2.150 Exhibit 76 shows annual dredging volumes since 1937. Dredging quantities generally declined until the 1950s when the trend leveled off. The major deviation, as noted in Exhibit 75, came in the late 1950s and early 1960s.

2.151 Several factors have had varying degrees of influence on the dredging trends shown in these two exhibits. The high dredging volumes in the 1930s and 1940s is related primarily to dredging associated with the development of the 9-foot channel and to a huge

"stockpile" of bedload materials which could readily shift into the newly dredged channel. In addition, the mid-1940s was a period of slightly higher than average flow and, hence, probably higher than average sediment influx.

2.152 The trend towards less dredging through the 1930s and 1940s reflects completion of the 9-foot navigation system and eventual depletion of the sediment "stockpile". Because of the navigation channel, the main channel of the Mississippi River increased in hydraulic efficiency. This probably increased the sediment transport capability and reduced the quantity of sediment being deposited within the navigation channel. In addition, bank stabilization and land treatment measures instituted particularly within the last 40 years may have reduced sediment yields at primary sources. Artificial impoundments, ranging from farm ponds or small intermittent streams to large multi-purpose reservoirs on major rivers, have acted as sediment traps, reducing the quantity of bedload eventually reaching the navigation channel.

2.153 Since the early 1950s, dredging quantities have been relatively constant with the exception of the late 1950s and early 1960s. In this period two factors combined to cause a temporary decrease in dredging volumes. The 10-year span from 1955 to 1964 included 9 years where the discharge was below the average for the period 1937-1972. Unquestionably, this reduced the amount of bedload materials reaching the navigation channel. This same period marked the takeover of Rock Island District dredging duties by the DREDGE THOMPSON. The addition of Rock Island District dredging to the THOMPSON'S workload may have been responsible for temporarily postponing some St. Paul District dredging as an efficient schedule of dredging operations was being developed.

2.154 The increase in dredging volumes within the last 10 years is related to higher than normal flows, including the two highest flows of record (1965 and 1969).

2.155 The policy of the St. Paul District with regard to overdepth dredging has not changed in recent years. District records indicate dredging to 13 feet has been standard policy for over 30 years. Records show that occasional experiments have been conducted to see if greater depths at certain locations would reduce the need for annual dredging. In the event that a large spring flood shortens the dredging season, selected locations may be dredged only to 11 feet to assure minimum depths for navigation and save enough time to permit the THOMPSON to cover the entire St. Paul and Rock Island Districts. These locations are then dredged to normal depths the following year, provided they don't require emergency dredging in the interim.

AD-A133 511 OPERATION AND MAINTENANCE 9-FOOT NAVIGATION CHANNEL 2/8
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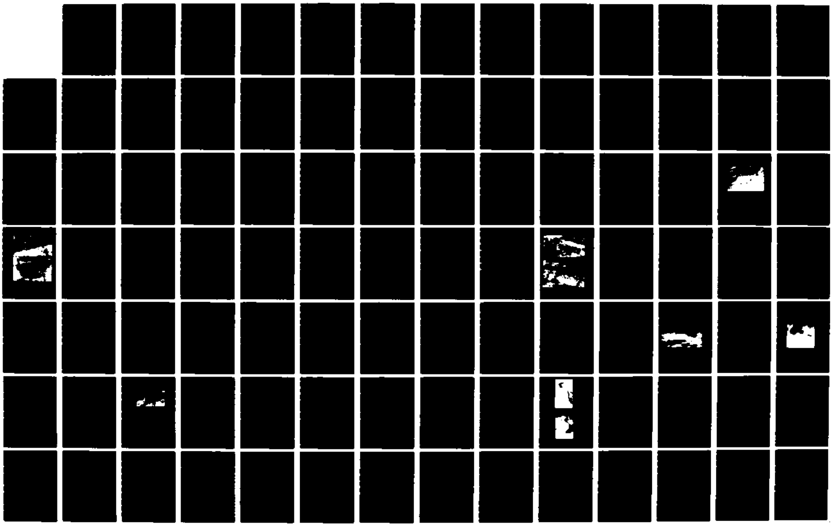

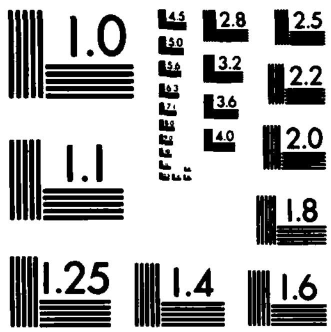
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BIOLOGICAL ASPECTS OF THE STUDY AREA

2.156 The various common associations of terrestrial and aquatic vegetation are listed in Exhibit 77 along with their more frequently associated animals. Recognizably, wildlife-habitat associations are seasonally dependent as well as correlated with vegetative continuity, successional stage of development and juxtaposition of habitat types. The crowded, narrow gorge below St. Anthony Falls has little development of marsh or floodplain forest and the aquatic habitat consists mostly of main channel and main channel border. In the lower reaches of pool 2, the floodplain widens for a short stretch and there is typical development of sloughs, lowland woods, and low meadows.

2.157 Downstream from Prescott, Wisconsin, the floodplain again spreads into the typical configuration of bottomland woods, marshes, and lakes. From the lower area of pool 4 through pool 10, the floodplain and most of its extensive marshes and shallow lake habitat is included within the Upper Mississippi River Wildlife and Fish Refuge. Because of extensive marshes and shallow lake situations, the downstream pools are especially productive of commercial and sport fish and are critical to the management of waterfowl of the Mississippi Flyway.

TERRESTRIAL VEGETATION

2.158 Upper and Lower St. Anthony Falls, the lower reaches of the Minnesota, the St. Croix River, and most portions of the Upper Mississippi River are contained within an island of mixed prairie vegetation types, in a westward-extending peninsula of mixed deciduous-coniferous forest consisting of white pine, yellow birch, and maple on heavier soils, and red and jack pine on sandier sites. On sandy soils to the northwest of the Twin Cities, there is an island of the drier deciduous forest. Small to medium-sized oaks predominate in this forest. West and south of these forests lies the tall grass prairie region which included bluestem and bunchgrasses and a rich assortment of nitrogen-fixing legumes. This prairie has built up the soils of this area to a rich level of productivity. Urban and agricultural development has disrupted or removed much of this vegetation on the level uplands.

2.159 The woodlands in the watershed adjacent to most areas of the Upper Mississippi River can be divided into two general groups; the upland xeric southern forests of Wisconsin and Minnesota, and the southern lowland vegetation of the floodplain. The upland xeric forests are predominately oak forests. They are located on well-drained sites on either sandy and porous flat lands, on south and west slopes of hills, or on thin soils on hilltops and ridges. In

a study of 127 forests located in the southern one-third of Wisconsin, including 80 percent of the Mississippi River bordering Wisconsin, 29 species of trees were found (Exhibit 78). An analysis of the groundlayer species indicate that more than one-half of the species are included in nine families. The family Compositae comprise 10 percent of the total species in the dry mesic stands, and ferns are dominant. Other families in the group of nine are the Gramineae, Ranunculaceae, Rosaceae, Umbelliferae, and Caprifoliaceae (Exhibit 79).

2.160 The valley forests are commonly known as bottomland or floodplain forests and the lake border types are usually termed hardwood swamps. They are similar because the soil moisture supply is in excess of that falling as rain. The floodplain forests are present along all the rivers tributary to the Mississippi and on the Mississippi floodplain. The composition of the forest differs greatly from the upland forests and groundlayers (Exhibit 80). Of the 37 species listed, 21 were found in the initial or wet segment and 36 in the intermediate wet mesic segment. The lowland forests thus have more species of trees than any other community in the area. Mostly, this is due to a number of species of southern derivation which have progressed northward in river valleys. The average values tend to obscure the fact that several different combinations of species are included within the wet segment. In the pioneer sites along sand bars, mud flats and other open places of recent soil disturbance the usual forest is dominated by black willow and cottonwood. On open sites near the upland edge of the wet ground, river birch or swamp oak are the usual dominants. As both of these types mature, they are invaded by silver maple and American elm. The moist forests, particularly the riverine stands, tend to have a high total basal area per acre, with an average of 14,300 square inches per acre. This is due to the large size of the trees rather than high densities. This can be substantiated by examining the size of the stumps remaining from the timber clearing activities in the navigation pool areas prior to inundation.

2.161 The prevalent groundlayer species of the lowland forest are reported in Exhibit 81. The floristic homogeneities are low as shown by the ratio of prevalent species to total species. Analysis of the total flora reveal that the same seven families include 50 percent of the total species. The main change in family representation as compared to the upland forests, is the prominent role of the sedge and mint families and the increased importance of the nettle and carrot families. The low values of average presence for the prevalent species of the wet stands are an indication of the great variation to be found from stand to stand due to the frequency of flooding.

2.162 The dominants in the wet forest type, in order of importance are: silver maple, black willow, cottonwood, American elm, and river

birch. The most common understory species are: wood nettle, poison ivy, wild grape, and woodbine.

2.163 The dominants in better-drained forest types in order of importance are: American elm, silver maple, green ash, basswood, and black ash. The most common understory species are: woodbine, wood nettle, touch-me-not, Jack in the Pulpit, and violet. *

2.164 Due to the temperate conditions in the bottomland a number of trees have extended their ranges well north of their normal ranges in the valley along the river. The major species are: Kentucky coffeetree, honey locust, smooth buckeye, river birch, and sycamore. With the exception of river birch, however, these species are relatively scarce.

2.165 Seedling reproduction and saplings typically have low densities in these stands. Germination and seedling survival are poor as a result of the periodic flooding. However, the plants that do survive and mature reach large size; silver maples, cottonwoods and swamp white oaks with a 17-20-foot circumference are not unusual. Many trees have multiple stems, a result of damage from ice and other debris in spring floods.

2.166 Lianas or climbing vines are extremely important in these stands. Poison ivy, woodbine, and wild grape are most common and may form as much as 25 percent of the canopy.*

2.167 Major vegetation types differed somewhat in the lower portion of the St. Croix River valley. White pine and red pine, occasionally mixed with grassland, were apparently more dominant than in other portions of the Upper Mississippi and Minnesota River valleys located within the study area.

2.168 The early logging operations of the Lower St. Croix valley left few of the original white pine or red pine stands except in isolated, steep-sloped areas where a few virgin tracts of these stately conifers still exist. The remaining pine are mainly second growth, principally located on the higher ground. They are intermixed with elm, oaks, ironwood and silver and sugar maple. Basswood, hackberry, dogwood, paper birch and aspen occur less frequently.

2.169 Several species of deciduous trees densely vegetate thousands of acres along the river valley. Boxelder, silver maple, elm, ash, and cottonwood are well represented in this zone. Forming an understory, and in cutover areas as well, are such species as chokecherry, dogwood, mountain maple, thorn apple, highbush cranberry and elderberry.

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* Curtis, J. T. 1959. The Vegetation of Wisconsin, Univ. Wisc. Press. pp. 657.

2.170 Trees on the bluff slopes include river maple, cottonwood, ash, elm, and willows along the shoreline. At higher elevations the tree species varied from a mesic association of basswood, ash, Norway maple, and ironwood to a more xeric association, including northern red oak, birch, quaking aspen, red cedar, and white pine. Under the mesic forest, the herb layer includes wild ginger, anemone, hepatica, bladder and flowering fern. Near the shoreline more moisture and sunlight are available; thus, goldenrod, asters, and columbine may occur near the wild ginger and hepatica, and at the water's edge, red-osier dogwood and duckweed.

2.171 A grassy slope with scattered red cedars occurs near the bluff-top on the left bank (Wisconsin side) at St. Croix mile 20. This site is a remnant of a savanna community, the prairie segment of which formerly had a wider distribution. Less than 100 acres of undisturbed cedar savanna are known to occur in Wisconsin. This community type is listed as an uncommon plant community in Wisconsin by the Wisconsin Department of Natural Resources.

2.172 Open habitats in most pools below pool 2 can be divided into well-drained areas subject to flooding but dry most of the year and poorly-drained areas, such as swamps and sloughs, covered by water with the exception of short periods during the dry season. The well-drained area included sandbars, islands and flats. It includes most of the newly formed land along the river channel. Willows and cottonwoods are the primary species of the pioneer stage. They usually seed in and germinate in approximately equal density. Further development depends upon subsequent moisture relations. The cottonwoods, are better able to withstand dry conditions in the early stages. Willow is favored by wet conditions since willows are more tolerant to saturated soil and spread by root sprouts. This combination of factors tends to favor willow dominance in most stands. With time, successional replacement with maples, elms, oaks, and associate species will occur.

2.173 Silver maple and American elm can invade the wet stands of cottonwood or willow and can then succeed themselves. Further changes in composition depend upon increasing drainage by down-cutting of the streams or building up of the land level, permitting the entrance of red oak and basswood. Originally, fire from the upland prairies would burn the marsh areas along the upland side of the channel during low water periods in the fall and invade the floodplain forests. The open stands remaining were invaded by swamp white oak and river birch. A similar situation occurred with abandoned agricultural land. With cessation of fires the stands underwent type succession with the entrance of burr oak, white oak, silver maple, and American elm. The linear nature of the stands tend to produce

uniformity of composition in the stands along long reaches of the river.

2.174 In the poorly drained areas tree reproduction occurs mainly during periods of low water during the dry seasons and subsequent flooding may exercise a selective effect on seedling survival. Willow, cottonwood, birch and boxelder are important colonizers in these areas. Further development toward wet-mesic conditions depend upon improvement in the surface drainage either by deposition of silt from flooding or by artificial drainage.

2.175 Areas near the main channel covered with old dredge spoil or with sandy outwash from such spoil are at a higher elevation than any other sites and support a vegetation different from other areas. They are dominated by xeric grasses, annual and perennial weeds, and small trees, mostly oaks. Willow shrubs are common in sections at lower elevations. These areas make up a small percentage of the total land area in the various pools but they are the places receiving considerable use by recreational users of the river.

2.176 The species which will colonize dredge spoil during the season it is deposited depends largely on the date of deposition. If this occurs before 15 July in the Twin Cities area, and a thin layer of silt forms the uppermost layer about 6 to 8 inches above the water table, prompt establishment of tree seedlings can be expected, especially of cottonwoods, peach-leaved willow, American elm, box elder, silver maple, and the very important shrub, sandbar willow. This vegetation would provide enough cover immediately to improve the appearance of the spoil as early as the second year, and would reduce blowing of spoil sand into the backwaters or back into the channel. On the floodplain in the Twin Cities area, exposed sand and mud deposits become vegetated by herbs such as teal grass, millet, smartweed.

2.177 Cottonwood seed germination is drastically affected by the time of flooding. For instance, a large crop of cottonwoods in 1922 was due to an extremely high flood that year, which receded and left a bare, moist soil just when the seeds were viable. The young seedlings of 1923, however, were completely destroyed by a rise of the water after germination. Because sandbar willows reproduce by runners as well as by seed, they are not subject to fluctuations in numbers to this extent.

2.178 Except for those forests which were clear-cut prior to filling the pools, plant species composition of terrestrial vegetation types have not changed significantly since inundation by the waters of the 9-foot navigation project. The upper third of each pool has retained the general characteristics of the land prior to the dams, thus retaining vegetative cover with little plant species change. Some loss of individual plants was inevitable with high water tables, but those species

native to the floodplain are usually able to withstand prolonged periods of high water or reclaim sites made more suitable than existing ones by changing water levels.

2.179 Within the forests which make up most of the area in the north ends of pools 3 through 10, herbaceous vegetation patterning is determined by the time at which soil surfaces are free of standing water in the early part of the growing season. The earliest land to emerge in those areas completely dominated by trees is covered with solid stands of wood nettle and with green dragon, generally present in limited numbers. Parts of the forest emerging before mid-June are likely to have at least some wood nettle coverage. Those shaded places emerging later are likely to have no herbacious understory cover at least up to the end of July, and few or no plants flowering or setting seed before killing frosts. Patches of sensitive fern are locally present, but not common. Poison ivy occurs abundantly in those places where more light reaches the forest floor. Common elder is often obvious in more open sunny areas within the forest, along with wood nettle, which is by far the most common shrub layer vegetation, although neither is abundant in the forest proper. Vine form poison ivy, Virginia creeper, wild grape, are common woody vines. The high unshaded edges of running sloughs in the forest areas often have thick stands of reed canary grass.

2.180 Little work has been done in studying terrestrial marshes, and there are no studies on record of composition in most pools. The short discussion here will be based on information developed by Curtis (1959) on sedge meadows in southern Wisconsin. The community is found in lands in which the surface is just above the water table, though at times it may be submerged. The dominant plants are sedges and bluejoint grass with a variety of broad leaved species also present. The most common include Canadian anemone, swamp milkweed, Joe-pye weed, and boneset. The community tends to be transitional between aquatic marsh and the bottomland forest. With the cessation of fire it may develop into a Shrub-Carr community. The understory remains sedge meadow but a tall shrub cover of red osier dogwood, several of the shrub willows, button bush, and indigo bush, invades and can develop into a stable community, only slowly invaded by tree reproduction of the wet forest.

2.181 The bottomlands have possibly been changed less than any other habitat in the area. Grazing, especially where the bottomlands abutted upland meadows, limited cutting, and limited recreational development were the chief modifications brought about directly by man. The majority of commercial development was usually limited to the terraces and indirectly affected the river through increased runoff, flood problems, and pollutant discharge. The removal of prairie and the cessation of fire most likely resulted in a decrease in open marshland and an increase in wet mesic woodland but this cannot be documented at

present. An important indirect effect is the widespread destruction of elm as a result of the spread of Dutch elm disease. Since elm is a major dominant in the bottomland forests, this may have an important effect on stand composition in the future. The building of the wing dams and closing dams resulted in an increase in island formation and a filling in of fringing bars expanding the terrestrial habitat. Any increase in terrestrial habitat is realized as a result of a decrease in aquatic habitat.

AQUATIC VEGETATION

2.182 Potential riverine aquatic vegetation in the Twin Cities area and further downstream may be grouped into habitat types, such as deep and shallow marshes and wood and shrub swamps.

2.183 The plant species that one might expect to find in these habitats include the following:

Habitat	Species
Wood and shrub swamp	Alder, willow, buttonbush, dogwood, swamp privit, assorted bottomland hardwoods.
Seasonally flooded flats	Sedge, grass, smartweed, oak, elm, willow and ash.
Moist meadows	Sedge, rush, redtop, reedgrass, mannagrass, prairie cordgrass and mints.
Shallow marshes (less than .5 ft of water)	Whitetop, rice, cutgrass, sedge, giant burreed, cattail and arrowhead.
Deep marshes (.5 to 3.0 ft of water)	Bullrush, spikerush, pondweed, naiads, coontail, water milfoil, waterweed, duckweed, water lily and spatterdock.
Open water (3 to 10 ft of water)	Waterweed, water lily and other submergents.

2.184 Aquatic vegetation habitat is lacking in the St. Anthony Falls pools due to extensive development and inundation of the former flood-plain. Similarly in pool 1 extensive development in the upper reach and a deep gorge downstream leave little room for aquatic habitat. No aquatic vegetation is known to occur in the channel proper.

2.185 Pool 2 - Extensive development in many places as well as inundation of the former floodplain limits aquatic habitat in pool 2. However, aquatic plants may be found in a few off-channel areas.

2.186 Submerged and floating flowering plants are generally lacking in Pig's Eye Lake, but emergent vegetation is found in all but the west and northeast shores. River bulrush is relatively abundant on the east, west and north shores. The value of this species to waterfowl is fair. Cordgrass, of similar value to waterfowl, is common on the east, west and north shores. Arrowhead, occurring occasionally on the north and south ends is of fair value to waterfowl, unlike smartweed which is of good to excellent value but which has been observed only occasionally around the shoreline. Narrowleaf cattail occurs occasionally at the south end of the lake. Generally, emergent vegetation is found on all but the west and northeast shores. River bulrush is the major emergent species, but there is some sizeable stands of smartweed and arrowhead.

2.187 The Department of Natural Resources (MNDNR, 1973) survey of the Pig's Eye area noted less than 1 percent occurrence of submerged vegetation. The greatest depth to which rooted, submerged plants grew was 2.5 feet. Sago pondweed, which is of excellent food value to waterfowl, is sparsely distributed along the west shore. Lesser duckweed is occasionally present at the north end. Also of fair to excellent value to waterfowl is greater duckweed which is scarce, present only at the north end of the lake.

2.188 The turbidity of the water is very high, due primarily to a bloom of blue-green algae. Experience in management of southeastern fish ponds indicated that large phytoplankton populations and heavy stands of aquatic vegetation are incompatible and that the heavy algal blooms are detrimental to rooted vegetation.

2.189 The Minnesota River - Aquatic vegetation occurring in the marshes and swamps of the Minnesota River bottoms include such floating species as duck weed, white water lily, and submerged plants including pondweed, coontail, and others. No record was made on the relative abundance of species.

2.190 St. Croix River - Aquatic vegetation is sparse in Lake St. Croix. Periodic high water and floods have resulted in a scoured condition along the shore. This, in combination with the steep and sandy bottom, has discouraged the establishment of most aquatic plants. The most important exceptions are wild celery and river pondweed. In protected backwater areas and sloughs other species of pondweeds, naiads, cattail, coontail, rushes, sedges, arrowhead, bur reed, and duckweed may appear. However, such areas are generally offstream, such as at the head of the lake just upstream from Stillwater.

2.191 Seasonal changes in phytoplankton and periphyton algae abundance have been recorded from the Upper Reach of Lake St. Croix (Stillwater to Hudson). These algal communities are composed mainly of three algal groups(divisions), including Cyanophyta (blue-green) Chlorophyta (greens), Chrysophyta (goldens and diatoms). Counts indicate each division may have its own seasonal maximum or "bloom." The Chrysophyta and Chlorophyta often bloom in spring and fall, while the Cyanophyta are most abundant during the summer.

2.192 A period of maximum abundance of attached (periphyton) algae generally occurs in the late summer and a minimum abundance occurs in winter. This is indicated by chlorophyll "a" concentrations occurring among attached algae collected from artificial substrates.

2.193 However, local limnological variations in the St. Croix River may noticeably alter community abundance and composition. During summer, the phytoplankton, particularly blue-green algae, may become quite abundant downstream from Hudson, Wisconsin. Where thermal effluents enter the river, blue-green algae dominate the attached algal community.

2.194 In winter, ice-free areas occur where thermal effluents, storm sewers, and springs enter the river, and where the river becomes narrow and shallow. The limitation of light upon algal growth is removed in these ice-free areas. Thus, attached algae may occur in abundance as shown by chlorophyll "a" concentrations near a thermal effluent.

2.195 Pool 3 - Aquatic vegetation is relatively sparse in the lower portion of pool 3. There are no great flooded areas other than North Lake and Sturgeon Lake which are a portion of the north end of Gores Management Area. The types of aquatic macrophytes most commonly seen are found in Exhibit 82. The upper portion of the pool (upstream of St. Croix River) is generally high-banked with little marshlands. The most extensive marshland habitat borders North Lake in mid-pool.

2.196 The current velocities and constant scouring by commercial navigation and recreational boat traffic deter any growth by submerged or emergent macrophytes along the main stem of the main channel. The river is relatively narrow in this pool, creating strong wave action on the shorelines.

2.197 Pools 4 through 10 - The following discussion on pools 4 through 10 is taken directly from a paper written by Green (1960) on ecological changes of the Upper Mississippi River since inception of the 9-foot channel. Green's report covers the river for the entire length of the Upper Mississippi River Wildlife and Fish Refuge and the state-

ments are applicable to pools 4 through 10. Dr. Green's records are quoted below:

> "The Upper Mississippi River valley is unique in its flora and fauna. It enjoys conditions not generally associated with its geographic location. What has been referred to as a "pseudo-Carolianian (sic) zone" extends north along the Mississippi into the Alleghanian (sic) zone. Thus, refuge flora and fauna, although primarily Alleghanian (sic), have representatives of Carolinian species as well as occasional Canadian forms. A feature making the refuge even more interesting is the overlapping of eastern and western species and subspecies. There are also several high "sand prairie" areas scattered along the length of the refuge, offering habitat conditions normally found much farther west. These sand areas reach elevations high enough to protect them from severe floods, and consequently have developed a flora very distinct from that of the true flood-plain, with plants of dry upland prairie predominating.
>
> At the time the refuge was established, the river bottoms were primarily wooded islands, with deep sloughs the rule, but with hundreds of lakes and ponds scattered through the wooded areas. There were some hay meadows on the islands, together with some small farming areas, but the bottoms were essentially wooded. Marsh development was limited to the shores of the lakes and guts leading off the sloughs. Marsh flora was also limited, with river bulrush making up the dominant habitat. These marshes often dried up completely by the end of the summer. Also, many lakes and ponds dried up completely, while water levels in others receded markedly. Fish rescue work was a big activity, with crews rescuing fish trapped in bottomland lakes and ponds when the river receded.
>
> Early investigators such as Vernon Bailey, F. M. Uhler, and A. O. Stevens found there was a nucleus of marsh and aquatic species present in the bottoms, but not in great abundance. Further, because most of the lakes and marshes were subject to periodic flooding and dried out in the summer and fall, marsh and aquatic development was limited. Bailey suggested whatever means possible to insure water in the lakes and marshes, and advocated construction of retaining dams to hold back floodwaters.
>
> Uhler also considered frequent changes in water levels of the flowing channels and the periodical or seasonal fluctuations in the lakes and ponds to have a greater effect on the development of aquatic plants in general than any other factor. He, too, suggested construction of small dams to hold water in lakes and ponds when the water receded in the summer.
>
> Constant drying out of marsh areas and ponds resulted in considerable loss to marsh and aquatic species, especially

the annual plants. Re-seeding occurred during periods of floods in the spring and fall, but good aquatic seeds were limited, and before they became well established recurring drying out would again eliminate or greatly reduce such growth.

In the early thirties, the Corps of Engineers initiated work on the 9-foot channel project for the Upper Mississippi. Thirteen of the 26 locks and dams constructed in connection with this project are located on the Upper Mississippi Refuge, and the first pool within the limits of the refuge was filled on May 29, 1935. The last pool on the refuge was filled in 1939.

The impoundment abruptly changed the river bottoms from an area of wide fluctuations in pool levels ranging from floods in the spring to drying out in the summer, to an area of semi-stabilized water in which, while spring floods still occur, the bottoms do not dry out in the summer. Thus, instead of wooded islands and dry marshes, we now have excellent marsh and aquatic habitat, with fairly stable water levels throughout the year. Even the two record floods in the spring of 1951 and again in 1952 do not alter the fact that water conditions are much more stable now than they were prior to impoundment. Spring floods always occurred, and they can be expected annually. However, instead of drying up in the summer and winter, there is now water available throughout the year in the marshes, lakes, and ponds. Lack of marsh and aquatic plants is no longer a problem, and fish rescue is a thing of the past. Hay meadows and timbered areas are now in marsh, which offers excellent habitat for furbearers and waterfowl.

In each of the thirteen pools on the refuge, three distinct zones occur. The upper end of each pool is in essentially normal river condition, where the water levels were not raised to any extent. In this portion of the pools, marsh development is limited, and the old condition of deep sloughs and wooded islands is found. In the middle of each pool, impoundment backed up water over islands and old hay meadows, spreading out over large areas of comparatively shallow water. It is in the middle portion of the pools that the best marsh development occurred. Immediately above each dam the water was impounded to a depth which precluded marsh development, and at present this area is essentially deep, open water, in which

some aquatic growth occurs but in which there is practically no marsh.

The best marsh development on the refuge occurs north of the Wisconsin River. In this area, especially in pools 4-7, the pools are short and impoundment had more pronounced effect on the development of habitat. Pools 8 and 9, although long pools, have developed much more than the long pools south of the Wisconsin River.

The year following impoundment, very dense beds of Muhlenberg's smartweed came in, often in such dense beds that the bottoms took on the reddish tinge of the blooms. For several years this species supplied an abundance of duck food. It was the growth of this species which led to the enthusiasm with which service personnel greeted initial improvement following first impoundment. For about five years following flooding this species produced an abundance of seed and during that time held the distinction of being the most important single species of duck food on the entire refuge. After about five years it was found that although in some areas it continued to make vegetative growth, in the few areas where it still hangs on it is almost entirely sterile. With the disappearance of this plant many areas had greatly reduced aquatic growth, but since various other aquatics, notably the pondweeds, have come in and have replaced it satisfactorily.

River bulrush, which was the most common marsh species prior to impoundment, has continued to be an important marsh plant. Coming in dense, solid strands for several years following impoundment, this species deliquesced for a few years, but has since made a comeback and is at present an important marsh species, especially for muskrats. Although this species seldom sets seed to any extent on the river, there have been years when it seeded heavily, and then it was of considerable value to waterfowl also.

Round-stemmed bulrushes do occur, however, and are spreading more each year. Of these, hard-stemmed bulrush occurs rarely. . . Slender bulrush was formerly more common than soft-stemmed bulrush, but the latter has increased to the point now where it is even more common than the slender species.

When impoundment first occurred round-stemmed bulrushes could be found in only small scattered patches interspersed with other marsh plants, but at present good-sized beds in solid stand can be found.

Cattail is still rare, although extending its range somewhat. Most of the stands are Typha latifolia, although there are two small areas in which T. angustifolia occurs.

Phragmites is important cover in pools 5 and 8, although it is rarely found elsewhere on the refuge except in these stands.

Extensive marginal beds of smartweed and millet occur on most ridges for the entire length of the refuge. Seven species of smartweed occur, although Pennsylvania smartweed is the most common and important. In the lower pools this association makes up a very important part in the food supply for waterfowl.

Burreed was present and well distributed, but not too abundant prior to flooding. Since impoundment this species has increased markedly. Shortly after impoundment the burreed-sagittaria association was the dominant emergent association on the refuge, but with the increase in other emergents, together with some reduction is burreed, the association is of lesser importance at the present time. It is still abundant enough, however, to be important for waterfowl cover and for muskrat house-building material.

Rice cutgrass is well distributed on ridges and islands. Locally, extensive marginal stands of this species occur, and since it usually seeds well, it is an important food. In wooded areas another cutgrass (Leersia lenticularis) is often more common than is rice cutgrass. Both species are valuable as duck food.

Extensive stands of sagittarias occur, with S. latifolia on the semidry margins and shallow water, followed by a zone of S. arifolia, and with S. heterophylla in beds in deeper water. While these plants are often found in association with burreed and bulrushes, there are extensive pure stands in many areas. These plants are important both to waterfowl and muskrats.

Wild rice makes intermittent growth, depending on water conditions and at the present time there are good stands of rice

present in the upper pools. Its ripening habit, together with the presence of myriads of blackbirds, which eat the seed almost as fast as it ripens, reduces its food value for waterfowl, although it is important as cover.

The most common aquatics on the refuge are American pondweed, sago, leafy pondweed, small pondweed, flat-stemmed pondweed, bushy pondweed, curly muckweed, coontail, elodea, water stargrass, wild celery, and the pond lilies.

Perhaps the most abundant species is American pondweed, which is the most important single species of aquatic so far as waterfowl food is concerned. This species occurs in all pools in extensive beds in a great variety of conditions from very shallow water to deep flowing channels. In the upper pools this species grows in such dense beds over extensive areas that boat travel is rendered difficult. It makes its best growth in water 12-30 inches in depth. This species normally is a heavy seeder and is of outstanding importance as waterfowl food.

Sago and flat-stemmed pondweed are also well distributed and abundant, both mixed with other aquatics and in pure stand. Sago ranks a close second to American pondweed, and has been increasing steadily. Flatstem, on the other hand, has fluctuated up and down, but at this time ranks third among pondweeds, and is often in pure stand over wide areas.

The coontail-elodea association formerly was the most common in ponds and lakes prior to filling of pools. Even after flooding the group was for a time the dominant aquatic association on the refuge. With continued stabilization of water, however, this association has been replaced over wide areas by more important pondweeds. Locally though, this group is still important.

<u>Naias</u> has increased, and at the present time occurs in pure stand over wide areas. This is especially important for blue-winged teal and baldpate, both of which feed heavily on the beds present.

Wild celery has spread until it can now be found almost the entire length of the refuge. It is most common in the upper pools, however.

So diversified are the aquatics on the refuge that it is not unusual to be able to find more than two dozen species in a matter of minutes anywhere in the better marshes and aquatic beds."

2.198 A listing of the aquatic plants of pools 4-9 is found in Exhibit 83.

MAMMALS

2.199 Wildlife habitat along the Mississippi River supports an abundant and diverse wildlife population. Mammalian habitat is varied and consists primarily of extensive marshlands, deciduous river bottom forest, moist sedge meadows, sand prairies, and limestone bluffs and steep slopes covered with mixed cedar and hardwoods.

2.200 The Upper Mississippi River system is unique in that it is geographically situated such that the distribution or normal range of a number of mammal species overlap. In addition, transition zones of major vegetation zones (i.e., prairie vs. deciduous forest) border along or near the river. There also exists a southerly climatic influence which extends further north along the river system than would normally be expected if latitudinal changes of climate were compared. Therefore, mammalian species are generally representative of eastern (Alleghenian) types, with some influence of southern (Carolinian) and northern (Canadian) species.

2.201 A list of mammalian occurrences within a major portion of the Upper Mississippi River was circulated by the Bureau of Sport Fisheries and Wildlife in 1968 (Refuge Leaflet 326 - Mammals of the Upper Mississippi Wildlife and Fish Refuge). Forty-nine species of mammals were listed as occurring within the refuge area with relative abundance ranging from rare to common. Three additional records were obtained of mammal occurrences within or near the refuge since 1968. A list of mammals found in the refuge is shown in Exhibit 84.

2.202 The whitetail deer is the only commonly occurring large herbivore within the Upper Mississippi River system. Their density is generally limited by the amount of available habitat and human disturbance, principally harvesting or hunting. Recent scattered reports indicate that moose and elk are rare visitors to the area. One recent sighting of a moose cow occurred in the vicinity of Stewartville, south of Rochester, Minnesota, during 1973. A bull elk was shot near Caledonia, Minnesota in 1964. Although more commonly occurring in the western part of Minnesota, two mule deer have been recently shot along the Upper Mississippi River, one each in Fillmore and Houston Counties.

2.203 Whitetail deer occur in moderate numbers along the river areas of the metropolitan area of Minneapolis-St. Paul. These areas include the floodplain forest and sloping banks of the Minnesota River, Upper and

Lower St. Anthony Falls, and pools 1 and 2. Somewhat higher densities are found along the St. Croix River and pools 3 through 10 where timbered habitat is more continuous and expansive.

2.204 Representatives of rodent types are diverse, abundant and occur in all types of available habitat. Rodent groups include two ground squirrels, one chipmunk, four squirrels, one pocket gopher and nine forms of mice (including three voles and one lemming). Other familiar rodents include the Norway or common rat, muskrat, and beaver. Nutria, similar in appearance to muskrats except for weighing 15-20 lbs., have occasionally been reported and actually trapped on one occasion in pool 6 near Winona, and once near Etter in pool 3 in the early 1960s.

2.205 Moles and shrews are each represented by two species. Six species of bats are known to occur in the area. The hoary bat is categorized as "rare" and was reportedly collected in 1966 at Buffalo City in pool 5. The cottontail rabbit is commonly observed while observations of white-tailed jackrabbits are less common and more confined to northern areas of the Upper Mississippi River. Porcupines are occasionally observed in more northern areas. It has also been reported but unsubstantiated that in the northern river areas snowshoe hares can be found in isolated pockets of favorable habitat. Larger carnivores such as black bears, cougar, and timber wolf frequented the bluffs and bottomlands in the past. However, occasional, unconfirmed reports of cougar or wolf sightings do continue to occur. It was reported that timber wolves denned among caves located along the rocky cliffs as late as 1930. Two recent sightings of black bears were made during the winter of 1972-1973 in the Whitewater State Wildlife Management Area north of Winona, Minnesota, near pool 6. In fact, one juvenile bear was shot near a farm house. The Minnesota Department of Natural Resources indicated that the bears were released as cubs by person(s) unknown.

2.206 Smaller carnivores are more numerous. Red fox are common throughout the Upper Mississippi River while gray fox are more frequently seen in southern portions. Coyotes and bobcats are on rare occasions observed in most areas. Lynx are occasionally found in the river area, but are undoubtedly northern migrants and do not establish permanent residence in the area. Feral house cats and domestic dogs occur more or less infrequently. Raccoons are common throughout the area and are also frequently observed along the river in the Minneapolis-St. Paul area.

2.207 Mustelids are represented by two species of skunks, the badger, mink, river otter, and two species of weasel. The least weasel is considered uncommon in the river area and it was not until 1969 that the longtailed weasel was trapped in pool 7 near the mouth of the Black River. The single marsupial known to occur in the area is the oppossum which is gradually extending its range northward.

2.208 Prior to the establishment of the 9-foot channel project, fur trapping provided an additional source of income for residents along the river. However, the intensity of trapping reduced the numbers of the more valuable species, particularly beaver and otter. Farming, timbering, and recreational industrial development also reduced the number of furbearers by altering habitat types. By the beginning of the twentieth century, the beaver, for example, seemed doomed to extinction and in 1910 a closed season was declared. Beaver were experimentally introduced at various points in the Upper Mississippi River Wildlife and Fish Refuge during the late 1920s. One small colony established in 1929 had increased to about 100 individuals four years later.

2.209 Completion of the 9-foot channel project initiated an increase of aquatic habitat in most areas of the Upper Mississippi River with a subsequent increase in numbers of aquatic oriented mammals. Increased protection in the form of regulating the harvest of some species and eliminating winter drawdowns also assisted in increasing numbers of aquatic furbearers. Beaver are now abundant throughout the Upper Mississippi River as well as in most of the tributary streams. During a period of high water levels in 1973, 40 beaver were counted in the vicinity of Pickeral Slough (pool 9) after their lodges were flooded and they were forced out into the open. The river otter is also apparently increasing in some areas, particularly in the northern sections of the river.

2.210 Other fur animals such as raccoon, mink, and muskrat have also responded with significant increases. Muskrats have flourished in marsh areas with about 800,000 muskrats being taken between 1940 and 1960 in the entire Upper Mississippi River Wildlife and Fish Refuge. During that same period, 19,000 mink were removed from the refuge. Fur animal population estimates by the Bureau in December 1970 in pool 9, for example, were 22,000 muskrats, 1,875,beaver, and 100 mink.

BIRDS

2.211 General - The bird life of the Mississippi River and its adjacent lands serves several public uses including hunting, birdwatching, nature photography, scavenging, control of insect and rodent pests, and enhancement of the general aesthetic setting. Since many of the characteristic birds of the river valley are migratory, the study area is of national and international significance in this regard.

2.212 The variety of the bird life is indicated by the numbers of species encountered; 280 species in the vicinity of the Twin Cities metropolitan area shown in Exhibit 85; 285 species in the vicinity of pool 3; 255 species on the Upper Mississippi River Wildlife and Fish Refuge, which includes the areas of pools 4 through 10. This is approximately 60 percent of the bird species recorded from the

entire conterminous United States. The diversity is attributed to the location of the study area along the Mississippi Flyway and within a region where the eastern and western ornithological ranges overlap. The project area is important to the migrations of waterfowl that breed as far north as Alaska and Hudson Bay. The division between the eastern and western ranges falls roughly at the hundredth meridian (central North and South Dakota). However, the eastern species tend to occupy river valleys further to the west and the western species edge eastward into the more arid uplands. In addition, the Mississippi River and its tributary valleys are a natural route by which the non-migratory or semi-migratory species may expand their ranges. The river valley forms a wildlife corridor between the Gulf of Mexico and the Great Lakes region.

2.213 Waterfowl - On an overall basis throughout the study area, waterfowl are generally regarded as being of the most important among birds. This is partly because duck hunting is an important form of recreation along the river and partly because of the migratory characteristics of the waterfowl. An average of roughly one and one-half ducks is taken per hunter trip based on hunter checks in public access areas. Over two dozen species of prominent Mississippi Flyway waterfowl are regularly noted on pools 4 through 10.

2.214 Backwater areas are of considerable importance to waterfowl. Nesting and brood habitat is provided for locally breeding diving ducks. Brood habitat is provided for puddle ducks such as wood ducks, mallards and blue-winged teal. Escape cover for broods and molting waterfowl exists among stands of backwater emergent vegetation. Food production for adults and broods include aquatic invertebrates as well as seeds, tubers, and foliage of emergent, submergent and floating aquatic vegetation.

2.215 The most frequent species of waterfowl utilizing the river during the annual spring and fall migrations include surface feeding ducks such as widgeon, mallard, wood duck, blue and green-winged teal, pintail, gadwall, black duck, and shoveller; and diving ducks, primarily the lesser scaup, ringneck, goldeneye, canvasback, and redhead. Peak numbers of spring and fall migrating ducks on the Upper Mississippi River Wildlife and Fish Refuge generally range from 160,000 to 230,000. In addition, whistling swans, snow, blue and Canada geese occur on the refuge in peak numbers of some 1,000 to 5,000 each during their migrations. The geese are found mostly in pools 7 and 8. These two pools also have extensive beds of wild celery and pond weed which has concentrated large flights of canvasback and redhead ducks during recent years.

2.16 In general, the present use of the river by geese is regarded as minimal due in part to shifts in population use patterns in response to refuge establishment. Geese in the Mississippi Flyway (Mississippi Valley

Population) respond to Horicon and Necedah National Wildlife Refuge in Wisconsin as well as various State refuges such as Crex Meadows in Wisconsin. Concentrations of geese remain at refuge sites until weather conditions force non-stop migrations to goose refuges of southern Illinois (Horseshoe Lake, Crab Orchard, Union County, Ballard County, Rend Lake). Canada geese utilizing the Mississippi Flyway are predominantly of the eastern prairie population which overwinter in Missouri. Snow and blue geese use of the valley is considered occasional.

2.217 Increasing breeding populations of the giant Canada goose subspecies (*Branta canadensis maxima*) are occurring along the Upper Mississippi River. Notable examples include a population of an estimated 180 breeding pairs during 1973 within the 7-county area surrounding Minneapolis-St. Paul and approximately 10 breeding pairs near the upper end of pool 8. A sizable segment of 12,000 to 15,000 giant Canada geese winter in the city of Rochester, Minnesota and utilize the Mississippi River to a limited extent.

2.218 The overwintering of waterfowl occurs in several areas along the river where open water is present year around. Pool 2, for example, has overwintered several hundred mallards and common goldeneyes during recent years. This is attributed in part to warm water discharges from the Twin Cities.

2.219 Casual bird counts indicate that many mallards and wood ducks utilize the St. Anthony Falls pools compared with the other pools. These two waterfowl species comprised 90 of the 130 individual bird sightings recently recorded in the St. Anthony Falls pools and included 25 ducklings. Most of these birds were sighted in the east channel around Nicollet Island and in the backwaters downstream from Hennepin Island. At Father Hennepin Bluffs Park several broods of mallards (14 young total, 1973) were observed swimming in and around the foot of Hennepin Island.

2.220 The Mississippi River valley's breeding ducks are primarily wood duck, mallard, and blue-winged teal of which some 4,000, 3,500 and 1,000 nesters, respectively, are recorded by actual observation annually on the refuge. The total nesting population is undoubtedly much higher. The most numerous breeding duck is the tree nesting wood duck. While wood ducks comprise only 0.2 percent to 1 percent of the population of the Mississippi Flyway, its production is important because the river is the heart of its breeding range and because it comprises 7.4 percent of the total kill (in spite of partial protection) due to hunter preference,

local abundance, and vulnerability to shooting. Approximately one-third of the wood ducks nest in the river bottoms, in the river bluffs, and in the river tributaries, respectively. Yet the hens are probably most successful in reproduction on the isolated river islands, because those that breed in the bluffs have a greater potential to lose their broods. The newly hatched duckling are commonly required to cross greater expanses of terrestrial habitat which borders the river, and those which reach tributaries have a long journey through the streams which have lost their quality for cover and food.

2.221 Shore and wading birds - An unusual phenomenon, for a large metropolitan area, exists in the location of two large wading-bird rookeries at the downstream tip of Pig's Eye Island on the Mississippi River, opposite the St. Paul stockyards. The largest one is a 170 nest, black-crowned night heron and common egret rookery, sandwiched between a large barge fleeting basin on the west and a large barge terminal on the east. This rookery is the largest in the State of Minnesota and is doubly important because elsewhere the night herons have been disappearing from their rookeries in recent years. About 1,000 feet upstream is a 60- to 70-nest great blue heron rookery. One evening, 24 of these huge wading birds were observed feeding along the remaining marshes in Pig's Eye Lake.

2.222 Herons from the Pig's Eye rookery probably use the Minnesota River valley frequently. In the summer of 1973, on a single 2-hour trip, nine herons were sighted flying up the Minnesota. Half a dozen others were seen feeding in Rice Lake near Highway 169. Records of many other sightings were taken during 1973 (see Exhibit 86). A total of 417 birds were sighted in the Minnesota River valley. Great blue herons and American egrets are a prime viewing attraction. Shore-birds, and associated forms, include Wilson's snipe, rails, woodcock, and several species of sandpipers. These birds occupy shoreline and lowland habitat.

2.223 Predatory birds - In addition to numerous red-tailed hawks and other broad-winged species, falcons, ospreys, and eagles utilize the valley for nesting areas, feeding areas, or as a migration corridor.

2.224 Early in the fall until freeze up, bald eagles gather in the Weaver Bottoms of pool 5, drawn there by the number of wounded water-fowl that are concentrated in the area. A particularly valuable feeding area for the bald eagle is the stretch of river from the Alma Dam (L/D 4) to the foot of Lake Pepin. Here fish are available in the open water with the greatest concentration to be found in the immediate vicinity of the mouth of the Chippewa River. Except for the foot of Lake Pepin there are often higher numbers below locks and dams 8 and 9 than anywhere else in the St. Paul District.

2.225 Most of the eagles along the river are the northern form; however, the southern bald eagle, an endangered species, is sometimes sighted in the Upper Mississippi River valley and has been identified here by banding records. The northern bald eagle is less rare and many are observed, for example, feeding at lock and dam No. 3 for about two weeks each fall.

2.226 The northern bald eagle, though not in an endangered status, like the southern form, is subject to the same forces that could decimate its numbers farther.

2.227 Several species of owls occur within the Upper Mississippi Wildlife and Fish Refuge. Owls which nest within the refuge include: the great horned owl, screech owl, barred owl, and saw-whet owl. The snowy owl occasionally migrates down this far from the northern forests of Canada.

2.228 Upland game and miscellaneous birds - Several species of upland game birds inhabit the valley. Ruffed grouse are present in limited numbers. Mourning doves are abundant throughout the river valley and are nesting residents. Bobwhite quail, pheasants and Hungarian partridge occur principally in association with agricultural lands. Woodcock use the valley extensively during their migrations and nest primarily in moist, wooded uplands. Double-crested cormorants formerly traversed the Mississippi Flyway in huge flocks during spring and fall migrations. Since the early 1960s, however, the numbers have dropped to a few sightings of very small flocks. Belted kingfishers and red-winged blackbirds are also commonly seen. The spring and fall migration of warblers are annual highlights for enthusiastic bird watchers.

2.229 Of the 280 species of birds which have been reported in the Twin Cities, 97 are common summer residents which nest in the area; another 98 species are present in small numbers, often as spring and fall migrants. Irregularly seen bird species, i.e., single sightings, account for another 85 species.

2.230 Within the St. Anthony Falls pools, the trees along the bluff slopes and tops, especially the small park areas, attract spring and fall migrating birds and also provide nesting sites for some summer residents as well. Considerable numbers of birds frequent the varied and relatively continuous and undisturbed bluff and floodplain habitats in pool 1. The trees along the bluff faces and tops, as well as on older spoil deposits contain numerous spring and fall migrants, and provide nesting sites for summer residents also. Herons observed flying over or roosting in the lock and dam No. 1 area are probably from the rookeries in pool 2 at the downstream tip of Pig's Eye Island.

2.231 Pool 2 also has a wide variety of birds. Casual counts in pool 2 show a preponderence of herons: great blue, green, black-crowned night herons and American egrets. In addition to herons, the floodplain lakes and marshes in the Minnesota River valley are important to mallards, teal, terns and red-winged blackbirds.

2.232 The lower reach of the St. Croix River provides a natural travel lane for wildlife, as well as a permanent residence for many game and non-game animals. The relatively steep-walled valley is well covered with numerous species of trees, shrubs and herbaceous plants that are highly attractive to a variety of wildlife. Vegetation on the floodplain, riverbank and islands is lush in many portions of the river. There have been no specific inventories of the bird and animal life along the lower St. Croix River. However, fairly intensive surveys have been conducted on the lower Kinnickinnic River valley by personnel from the Wisconsin State University-River Falls. Lists of birds and other animals are available for the lower Kinnickinnic River valley (see Exhibit 87).

2.233 In the marshes of pool 3 are found grebes, rails, waterfowl and also smaller bird life such as terns and blackbirds. In the damp meadows, marsh songbirds, herons, rails and waterfowl are found. In the sandy shorelines and mudflats there are typical shorebirds, numerous waterfowl and wading birds.

2.234 The birds of the pool 3 region number about 285 species. There are about 97 considered as summer residents and/or nesting species. The rest constitute regular or occasional migrants, or those of variable status, including some of rare or accidental occurrence. One variety of swan, four kinds of geese, and 26 kinds of ducks have been observed in the pool 3 area. Birds of prey, including the southern form of the bald eagle, an endangered species, are also present.

2.235 Pools 4 through 10 are included largely within the Upper Mississippi River Wildlife and Fish Refuge. Since its establishment in 1924, 255 birds have been identified on the refuge. Those species which are most commonly seen in the area are listed in Exhibit 88.

2.236 The creation of the navigation pools has had a varied and complex effect on migrating waterfowl along the Upper Mississippi River valley. Waterfowl utilization has fluctuated in relation to continental population changes, shifting migratory use patterns and quality of habitat. In general, however, use by migrating scaup probably increased greatly and has remained high since the creation of the pools while the use by canvasbacks, mallards and widgeons which first greatly increased has now abated somewhat. Usage by

geese has diminished significantly. In addition, creation of the pools has reduced nesting habitat especially for wood ducks. Impoundments also tend to concentrate waterfowl making them more vulnerable to overshooting.

2.237 Prior to the 9-foot channel navigation project, marsh and semi-aquatic bird species were not as prevalent in the valley. The drying out of marshes during the summer and fall was probably detrimental to some types of marsh and aquatic development. The wet-dry cycle in the marsh and pond areas was not conducive to the production of an abundant food supply for waterfowl. Few birds remained in the area for any length of time because of the derth of food. For downstream pools in the St. Paul District, a marked increase in waterfowl usage was evident after completion of the impoundments.

2.238 The stabilization of the water levels caused by the locks and dams resulted in an increase of emergent and submergent vegetation. This vegetation was extremely attractive to dabbling ducks, and along with a system of refuges along the river, greatly increased their usage of the river during the 1940s and 1950s. However, during the 1960s this vegetation, particularly the submerged, has deteriorated somewhat result-in a corresponding decrease in dabbler usage.

2.239 Vegetative deterioration in backwater areas has been attributed to various factors including constant water levels, reduction of circulation, movement of sandy bedload, excessive turbidity, and severe flooding.

REPTILES AND AMPHIBIANS

2.240 Stabilization of the Mississippi River by the 9-foot navigation channel has benefited some aquatic forms of reptiles and amphibians. The erratic drying out of the sloughs of the floodplain has been prevented by the dams. The floodplain of the Upper Mississippi River Wildlife and Fish Refuge affords habitat for nine species of turtles, 13 species of snakes, one species of lizard, two species of salamanders, one species of toad, and nine species of frogs. The list of 35 reptiles and amphibians of the Upper Mississippi River presented in Exhibit 89 represents observations and specimen records by personnel of the Upper Mississippi River Wildlife and Fish Refuge and local ecological institutions over a 40-year period. Refuge lowlands harbor myriads of frogs, turtles, water snakes, and other species that require aquatic or moist situations. The drier, elevated bluff slopes and sand prairies support forms like the box turtle, race-runner, hog-nosed snake, and bullsnake.

2.241 Timber rattlesnakes frequent the upper wooded slopes and bluff crevices, while the northernmost bottomlands offer a retreat for the massasauga or swamp rattler. Thus, the river valley provides all the various

requirements of shade, warmth, moisture, or aridity for the diverse amphibian and reptilian life.

2.242 Dredge spoil deposits are heavily used by soft-shelled turtles as nesting sites. The turtles prefer sandy beach areas which are not heavily vegetated and which are not open for more than 15 feet along the shore. Gradually sloping beaches are preferred over steep beaches. Most turtles nest in a zone between 14 and 30 feet from the shore. Snapping turtles, soft-shelled turtles and bullfrogs are locally important along the lower pools and are commonly captured for use as food.

FISH

2.243 Approximately 123 species of fish occur in the Upper Mississippi River (Exhibit 90). The fish fauna is predominantly of a warm water type except for whitefishes (family Salmonidae) which are found in many of the cooler lakes and four species of trout which occur above the St. Anthony Falls and in the cooler tributary streams. It is presently thought that the brook trout is native to the cooler tributaries below the Falls but that the brown, rainbow and lake trout were certainly introduced. Other prominent groups in the fish fauna of the study area include the pike (family Esocidae), the suckers (family Catostomidae), the true minnows (family Cyprinidae), the catfish (family Ictaluridae), the perches (Percidae), the sunfishes (Centrarchidae), and the sea basses (Serranidae)

2.244 The St. Anthony Falls have been a barrier to the upstream migration of fish for about 10,000 years. Only about one-half of the species of fish in the Upper Mississippi River were known from above the Falls as of about 10 years ago.

2.245 The northern pike and the muskellunge are important game fishes above the Falls. Muskellunge are not as numerous as northern pike, but this fish is not uncommon above St. Anthony Falls. Muskellunge are extremely rare in the Mississippi River below the Falls whereas northern pike are common. The sucker family is represented below the Falls by about 16 species, 4 of which also occur above the Falls, however the remaining 12 species are southern forms which do not range as far north as the St. Paul-Minneapolis area. About 23 species of minnows, including the introduced carp, occur both above and below the Falls. The catfishes are represented by 7 species below the Falls but only 4 above. The 3 important gamefish species of the perch family, the walleye, the sauger, and the yellow perch, are found above and below the Falls. A particularly interesting and colorful but little known subgroup of the perches, the darters, is represented by 15 species below the Falls and 6 above. The sunfish family, also important to the sport fishery, includes the largemouth bass, smallmouth bass, black crappie, bluegill, pumpkinseed, green sunfish, rock bass, and white crappie. All of these except the white

crappie occur above and below the Falls - the white crappie has never been taken above the Falls. The only member of the sea bass family known to occur above the Falls is the white bass, which only recently was recorded there. The white bass is important in the sport fishery below the Falls.

2.246 An unusual member of the fish fauna of the Mississippi River is the paddlefish (Polyodon spathula), the only known relative of which is the paddlefish (Psephurus, sp.) of the Yangtze River in China.

2.247 The American eel (Anguilla rostrata), once common as far up-river as St. Anthony Falls, is now considered rare. Eddy in Northern Fishes (1960) attributes their decline to the effects of the dams on the river.

2.248 There are apparent differences in the number of fish species in the various pools. For example, sixteen species are recorded at Coon Rapids; pool 2 has four times that number of species; 60 species have been found in Lake St. Croix; and 80 have been identified in pool 9. This apparent trend toward a greater number of fish species may reflect more extensive sampling in the downstream pools but may also be due to the greater number of backwaters with higher quality water and habitats downstream when compared with upstream pools. The implication of possible upstream pollution is supported by benthic invertebrate data collected in the summer of 1973. This data seems consistent with established trends of a river under pollutional stress conditions.

2.249 Abundant catches of large fish are described in the records of early explorers. Their liberal use of vernacular names, e.g., "trout", "Pike", and "carp", does not, however, permit a good assessment of species abundance. It is generally known that lake sturgeon were extremely plentiful in early times, and that many of the game fish were those characteristic of fast chutes and gravel bottoms, such as smallmouth bass and walleye.

2.250 Fishery management of the resources on the river was most intense during the period from the early 1870s to the time of the impoundment of the navigation pools. The 1870s were a period of increasing alarm over the declining of fishery resources in the United States and the Upper Mississippi River. The river was stocked extensively with American shad, Atlantic salmon, and carp. The famous fish rescue work began in Iowa and was continued until the impoundment of the dams. In the early 1900s the necessity for artificially propagating fresh water mussels became generally accepted and this led to the development of the Fairport Biological Station at Fairport, Iowa. The programs of fish propagation carried on at the station included the production of fish for stocking

midwest lakes and streams and the harmless infection of fish with the parasitic larval stages (glochidia) of mussels to insure mussel propagation.

2.251 After attempts to stock the river with several species, including the Atlantic salmon which never became established, the carp was introduced in the early 1880s. The first records of carp taken in the river were in 1883 at Hannibal, Missouri , and Quincy, Illinois. Carp were taken at Lansing in the 1880s and at New Albin in 1887. The catch of carp increased, and equalled the weight of buffalo caught in 1899. and since 1922 has outweighed buffalo 3 to 1. Buffalo correspondingly declined. Carlander (1954) cites three principal factors that could have led to the decline of the buffalo fish: (1) Overfishing coupled with selective fishing pressure (i.e. the buffalo fish is more valuable than carp). (2) Ecological competition with carp and (3) Habitat alteration. In all probability, these three factors were synergistic in effecting the decline of the buffalofish.

2.252 Between 1941 and the present, the annual poundage of carp handled by the Ehrlich Fishery at Lansing, Iowa, increased from 2-4 hundred thousand pounds to 10-17 hundred thousand pounds, indicating that the shallows created by inundations have greatly aided carp reproduction.

2.253 The construction of wing dams increased the rate of water flow and scoured the channel of silt, exposed sand bottom in the channel area and added to the rock surfaces provided by the wing dams and riprapping. These areas provided lush feeding grounds for large numbers of smallmouth bass, crappies, northern pike, and walleyes. However, the wing dams have also tended to concentrate fish into smaller areas. In some areas there has been a net loss of habitat due to extensive sedimentation between the wing dam.

2.254 The construction of the locks and dams for the 9-foot navigation channel has created lake-type pools causing a change from fast water species such as the smallmouth bass, to an increase in fishes whose environment is pondlike, as the largemouth bass, bluegills, crappies, carp, buffalo and northern pike. The dams also slowed the current and increased deposition of silt. The sediment sometimes covers the sand and gravel bars necessary for the feeding and breeding of such fish as small mouth bass and walleyes. Studies on the paddlefish indicate they also require gravel beds or particular water depth for breeding, so that sedimentation may have been more important in their disappearance than restriction of migrations by dams. There has been a corresponding increase of fish which are tolerant of mud bottoms.

2.255 The construction of the Keokuk Dam in 1913 for hydroelectric power was the first of several dams on the Upper Mississippi River which interfered with north-south movements of migratory fish. These included paddlefish, American eel, skipjack, Alabama shad, buffalo, shortnose gar, drum, shovel nose sturgeon, three species of catfishes, and blue suckers. Subsequently, there has been a considerable reduction in the numbers of

paddlefish, eel and blue catfish, and possibly the extirpation of skipjack north of Keokuk. No specimens of this species have been taken in 20 years. The disappearance of the skipjack was closely followed by the disappearance of the niggerhead clam, which depended on the skipjack for survival.

2.256 An appropriate summary of the effects of civilization upon the river is given in the following paragraph which is quoted from page 25 of Harriet Bell Carlander's book (1954), A History of Fish and Fishing in the Upper Mississippi River:

> "Man has changed the Upper Mississippi River both deliberately and indirectly. These changes have had their effect both on fish and on fishing methods. It is almost impossible to separate the effects of the various changes, or even to say whether the individual changes were favorable or unfavorable to the fishery resources of the river."

2.257 The status of the commercial and sport fisheries on the river is high. The commercial fish harvest during post-impoundment times has been mostly greater than prior to the dams. The increased productivity of commercial fish species is important. It should be noted that the increase in catch of these species since preimpoundment could be a reflection of fishing pressure and improved fishing technology as well as the expansion of roughfish habitat due to impoundment. The sport fishery also remains important with sunfish, bass, catfish, northern pike, and walleye making up the bulk of the sport fishery harvest.

2.258 The increase in relative numbers of carp, gar, and bowfin have been felt by many fishermen to depress the number of gamefish. The increased turbidity, probably intensified by the carp feeding, would interfere with the feeding by gamefish, which feed by sight. The increase of gar and bowfin are felt to cause some predation upon gamefish, however, there is some indication that these predatory species might be beneficial by preventing overpopulation and subsequent stunting of the fishery, particularly panfish.

2.259 Sedimentation has also filled in some backwater sloughs to the point where fish sometimes suffer winterkill due to oxygen depletion or freezeout. Nevertheless, the river particularly below pool 3 supports a very productive fishery. The river in pools 4 through 6 is estimated conservatively to have a carrying capacity of at least 300 pounds of fish per acre.

2.260 One species of fish, the lake sturgeon (Acipenser fulvescens) from the study area is listed as "threatened" by the United States Department of Interior, Bureau of Sport Fisheries and Wildlife. Large numbers of this fish were taken by early fishermen and many were also

destroyed because they damaged fishing gear. Because of their slow rates of growth and late maturity (sturgeon reach maturity at about 20 years and females do not spawn every year), they are now very uncommon. Lake sturgeon are completely protected in some areas and partly protected in others by size limits that permit them to reach maturity. Their numbers seem to have increased under protection within the entire geographic range of the species. Information on the status of the lake sturgeon within the 9-foot channel project is lacking, however local State and Federal resource agencies feel that this species is rare within the area.

AQUATIC INVERTEBRATE ANIMALS

2.261 The invertebrate organisms of the study area occur predominately as either benthos (organisms living on or in close association with the bottom substrate) or as aufwuchs (organisms living on rocks, rooted plants, or other surfaces which project above the bottom). The most important aquatic habitats for the production of aquatic invertebrates are the backwater sloughs, the main channel border (especially the wing dams), and the tail waters.

2.262 The aquatic invertebrate animal life of the river includes hundreds or possibly thousands of species, many of which have not yet been recorded. For example, twelve benthic organisms new to the record for the St. Croix River were found during the field investigations made specifically for this report. The fresh water mussels and the aquatic insects are among the most important groups.

2.263 The relative abundance of invertebrates at any particular site is dependent primarily on substrate type which is determined by current velocity. Course gravel or silt habitats have high populations and fine sand has the lowest population. There is a general trend of increasing numbers of invertebrates but decreasing variety (kinds or species) per square foot as one moves downstream in a given pool or on the entire study reach of the river. The increase downstream in pool 1 in numbers of bottom dwelling insect larvae and worms agrees with the increase in organic content of the bottom sediments and the decrease in sediment particle size.

2.264 A comparison of the data on benthic organisms collected in the summer of 1973 in the St. Croix River pool shows that the most abundant populations were collected near the mouth of the Kinnickinnic River. Midge larvae were most abundant in the quiet backwaters, while a large population of worms was found in mid-channel. At other stations in the St. Croix River, the abundance of benthic organisms was very low.

2.265 There are also seasonal trends in population abundance with the lowest values occurring during high waters in the spring, increasing to a peak in late May followed by a decrease into mid-July as a result of the emergence of the larval forms. Repopulation by the young larval stages begins in August and levels off in September-October.

2.266 Seasonal investigation of aquatic macroinvertebrates has been conducted at the confluence of the Mississippi and Chippewa Rivers in pool 4. Collections were made at sampling stations on the Mississippi one mile above the confluence, three miles below the confluence, and a third station was located one mile up the Chippewa. The invertebrates collected at the two Mississippi River stations are listed in Exhibit 91.

2.267 Bottom dwelling invertebrates and phytoplankton were sampled during 1973 at many sampling stations as a part of the background research for this report. The sample sites included stations both off and within the main channel. The benthic samples are summarized in the various assessment reports for the individual pools and specific areas presented in Exhibits 92 through 95 of this report.

2.268 The benthic field studies conducted in 1973 included 64 collections made from 22 standard and special transects of the three major rivers in the metropolitan area. Until this time, bottom organisms had not been studied extensively in the Upper and Lower St. Anthony Falls pools, as they had been in other segments of the river. In some cases the variations in invertebrate populations are closely related to polluting effluents. For example, the density of bottom organisms generally increased going downstream in the lower reach of the Minnesota River in 1964, although there was much variation. Apparently the increase consisted mostly of sludge worms (Tubificidae). In the sandy bottom 62 midges per square foot were found above the American Crystal Sugar Company effluent (at river mile 27.7). Downstream of the effluent for about 1,000 feet, organic sludge and parts of beets were found in winter of 1964. At mile 27.7 there were three sludge worms per square foot and 4.7 miles below this point, one per square foot was found. At mile 16.8 the animal numbers, primarily represented by sludge worms, were 33 per square foot and increased progressively to a maximum of 487 per square foot at mile 7.4. The total numbers then dropped to 150 per square foot at mile 1.9. Thus, organic wastes seem to be a dominating influence on abundance in some situations.

2.269 Aquatic Insects. - The aquatic insect fauna of the study area is generally dominated by immature stages of mayflies, midges, and caddis flies. The stoneflies, beetles, dragonflies and damselflies, and the backswimmers also occur frequently in samples of aquatic insects.

2.270 Although great numbers of mayflies often emerge simultaneously causing nuisance problems for river residents, motorists and towboat personnel, their presence indicates that the water retains high oxygen levels. Nymphal forms of the three major species of mayflies (*Hexagenia bilineata*, *Hexagenia limbata* and *Pentagenia vittigera*) are important food organisms for many species of river fish. The nymphs are efficient converters of detritus to high quality fish food. The abundance of *H. bilineata* and *H. limbata* has increased by the formation of the silted impoundments associated with the 9-foot channel project. Both species are dependent upon a silted substrate for the construction of their burrows.

2.271 Very little is known concerning the biology of Pentagenia vittigera, but it is generally assumed to be an inhabitant of the river bottom along the edges of the main channel and is apparently not dependent upon silted conditions for its existence as are H. bilineata and H. limbata. The formation of the 9-foot channel impoundments has apparently not affected the distribution of P. vittigera appreciably.

2.272 In 1972, Hexagenia mayfly populations were sampled above and below lock and dam No. 5A to determine the relative abundance and distribution of H. bilineata and H. limbata as related to environmental conditions. It was determined that sand bottoms were always devoid of Hexagenia nymphs. This was especially true in the main channel of the river but was true also in backwaters and side channels wherever considerable current kept the bottom free of fine silt. Areas which had a bottom composed of a mixture of sand and silt contained significant mayfly populations. The best habitat in the entire study area was found at the foot of pool 5A in a silted area known as Polander Lake.

2.273 Even within the lake the nymphs were numerous only in those areas which had been sloughs prior to construction of the dam, and where deep deposits of silt provided excellent habitat. Old land surfaces and former islands now flooded by the dam did not produce great quantities of nymphs because the substrate was too hard for burrowing. Areas of fine silt with vegetation provided no nymphs.

2.274 Elsewhere, at Crooked Slough, near Winona, even though the bottom was apparently of good texture for mayfly growth, no mayflies were present. It was concluded that oxygen deficiencies occurred at the bottom because Crooked Slough had been isolated from the river by the earthen dike of lock and dam No. 5A. This isolation stopped water circulation, allowed the slough to stratify and thereby precluded the existence of burrowing mayflies.

2.275 Invertebrates drifting through the water were sampled in pool 6 in 1967. Nine collections were made from each of two nets which were suspended one foot below the water surface along the Minnesota edge of the main channel at mile 720. The mayfly nymph (Hexagenia limbata) was numerically and volumetrically the most abundant organism collected. This indicates that Hexagenia nymphs often form the bulk of the animal biomass which drifts down the main channel. Hexagenia nymphs produced in the silted backwater sloughs of the river can obviously be utilized by fish feeding in the main channel or in the tailwaters. Pools 5 through 10 produce vast numbers of burrowing mayflies (Hexagenia bilineata and H. limbata). The production of mayflies in pool 4 is inhibited to some degree by water pollution.

2.276 Impoundment and enrichment of the Upper Mississippi River has increased the carrying capacity of the river for Hexagenia mayflies. However, pollutants from the Twin Cities have reduced mayfly numbers

for 30 miles downstream and also throughout Lake Pepin. Also, the constant loss of silted areas due to the encroachment of sand is reducing both populations of burrowing mayflies and dependent fish species.

2.277 The midge larvae, which are well known among fishermen for their contribution to the fishery forage base, are also characteristic of backwater sloughs with silt bottoms. Densities of approximately 650 midge larvae per square meter were found in a lower reach of the Minnesota River in 1964. Midges were also prominent in the drift net samples from pool 6, indicating that they also contribute to the tailwater fisheries.

2.278 The immature, aquatic stages of caddis flies are particularly abundant in aquatic habitats which have current and solid substrates such as rock, rubble, or submerged woody vegetation.

2.279 In a study of pool 6, invertebrates colonizing solid substrates in areas exposed to current were sampled at 54 locations along six transects in 1973 using a biplate modification of a multiplate sampler. The transects were spaced about equidistant throughout the main channel of the river between mile 719.8 and 724.0. Sampling was done at all seasons of the year. The most abundant organisms in this lotic environment were the caddis flies, *Cheumatopsyche campyla* and *Hydropsyche orris*. On a yearly basis, these two species also constituted the bulk of the biomass on the samples (67%). Various chironomids (Diptera) comprised 19% of the yearly biomass accumulation on the samplers.

2.280 *Miscellaneous aquatic invertebrates*. - Other insects encountered (aquatic invertebrate groups) during the background studies for this report included aquatic earthworms, aquatic mites (closely related and somewhat similar to the spiders), scuds or amphipoda (shrimp-like organisms), and zooplankton.

2.281 The aquatic earthworms are mostly sludge worms. These are tube-building forms which have their greatest concentrations in streams and rivers which are polluted with sewage. They are able to thrive in waters which have low concentrations of dissolved oxygen and are even able to withstand the complete absence of oxygen for long periods. For example, one-third of sample populations of *Tubifex*, a common form, have survived anaerobic conditions for periods of 48 days at temperatures just above freezing.* The survival rate with high temperatures is lower. *Tubifex sp* was encountered during the background studies for this report

* Pennak, R. Freshwater Invertebrates of the United States, 1953.

generally in polluted situations. Densities of 487 per square foot (5,571 per square meter) were also encountered in 1914 by the Federal Water Pollution Control Agency in the lower Minnesota River below the American Crystal Sugar Company effluent. The aquatic mites and amphipods were found among the invertebrate drift collected from pool 6.

2.282 Data on zooplankton were collected from pool 9 in 1972 (see Exhibit 92). Zooplankton population densities ranged from 0.2 to 16.3 organisms per per liter of water. *Eucyclope agilis*, a common copepod, was the most common form. Biomass, expressed as milligrams of dry weight per liter of phytoplankton and zooplankton combined ranged from about 4 to 5 grams. Plankton samples were also taken during 1973. The data were similar to those collected in 1972.

2.283 Fresh Water Mussels. - More species of fresh water mussels are found in the Mississippi River basin than in any other river basin in the United States. For this reason, the Mississippi is thought to be the origin and the center of development of the fresh water mussel fauna of the new world. The mussels of the study area are included in two distinct groups (taxonomic families): the Sphaeriidae or fingernail clams (which seldom exceed 1/2 inch in length); and the Unionidae which are much larger. Some of the representative forms are listed in Exhibit 95.

2.284 The fingernail clams are found on all types of bottoms except clay and rock and occur at depths up to 20 feet. These forms are regularly eaten by a variety of fish including gizzard shad, buffalo fish, suckers, and perch; waterfowl, especially scaup; and turtles. In favorable situations, over 5,000 clams may be found per square meter of bottom. Large numbers of fingernail clams have occasionally been found on mud flats along pool 10 after spring floods. They apparently die there after being deposited during flood stages. The suitable habitat for fingernail clams was increased by many thousands of acres as a result of the navigation dams. This benefited the fish, waterfowl, and other organisms which utilize them as food.

2.285 The unionid group are a much larger species of mussels which require stable bottoms of sand or gravel and are most abundant in waters less than 6 feet deep. This group includes many forms which are eaten by raccoon, muskrat, mink, and otter; and several of the species were formerly of commercial importance. Most of the 39 species of mussels which were known from the river at the turn of the century were of the unionid group.

2.286 The clam beds of the river were relatively undisturbed, except for use as food by the Indians, until clamming began in Muscatine, Iowa, in response to the needs of the pearl button industry in 1889. The beds near Muscatine were rapidly depleted, and by 1899 clamming was the most important fishery in Wisconsin when 8,000 tons were taken. The "niggerhead" was by far the most important species, with lesser numbers

of "yellow sand shells," "blue points," "hatchet-beaks," and "pocketbooks." The intensive commercial harvest was implicated in the depletion of the mussel beds. Clams grow very slowly; for example, a 4.5 inch "niggerhead" shell is 15 to 18 years old. In addition, clammers often threw undersize clams or unusable species on the banks so they would not be bothered with them again. The severe decline in the clamming industry during the 1940's was due to this and other factors. The clam market became overstocked with button blanks during the 1910's and 1920's, and by 1930, siltation and pollution were seriously affecting the mussel beds. The effect of the navigation dams was to slow the current, thus allowing silt to accumulate, converting many of the formerly productive mussel beds to other kinds of aquatic habitat. Clam populations in Lake Pepin, in particular, have been hard hit. Sludge deposits caused by upstream pollution have contributed significantly to the reduction of the mussel beds of previous years.

2.287 The development of the 9-foot channel navigation project appears to have had three distinct impacts upon mussels. The unionids, which must spend a portion of their lives as an attached parasite (glochidium) upon a fish, may have been adversely affected by the reduced migration of some fish species. For example, the inhibition of the migration of the skipjack, the main host for the larva of "niggerhead" clams, by the construction of navigation locks and dams is said to have all but exterminated this clam. In the 200 tons of clams taken from pool 10 in 1972, a dozen were niggerheads. The larger species in abundance today are "washboards" and "three ridges" with lesser numbers of "muckets," "warty-backs," and "maple leafs." On the other hand, the navigation dams may eventually be responsible for increasing the ranges of certain mussels because of the upstream movements of fish through the Upper and Lower St. Anothony Falls navigation locks. The populations of fingernail clams were mostly increased as a result of the dams. The increased production of these smaller forms is responsible in a large degree for the use of the pools by migrating waterfowl. This is especially true of scaup which feed extensively on fingernail clams.

2.288 The clammers believe that sedimentation has destroyed much of the beds although turbidity, within limits, also initiates feeding by clams. Since clammers use an underwater sail or "mule" for propulsion, they are aware of the changes of the rate of flow over the beds. They are quick to point out that not only has the average rate of flow decreased, but by closing the dam rollers the flow essentially ceases on certain days.

2.289 Although the variety of clam species on the river remains diverse, their populations generally remain sparse along most of the Upper Mississippi River. During studies conducted in 1947 on the Mississippi River, 13 species of mussels were found in the vicinity of Fort Snelling. Some 27 species of mussels were found in this area during the 1880s. No mussels were among bottom samples which were taken in pool 2 during 1973 as a part of the background research for this report. Mussels

were also abundant in the lowermost 35 miles of the Minnesota River during the 1930s, but only one living specimen was obtained during studies made in 1966. Increased numbers of mussel shells have been observed recently along the banks of the lower Minnesota River, suggesting that some recovery of mussel populations may be underway.

2.290 A study of Minnesota mussels (clams) published 26 years ago showed that 33 species of the 44 reported from the state were found in the St. Croix River. Of these 33 species, six have been found recently in the upper reach of the lake as have nine species of snails. One of the mussels found in the earlier study, Lampsilis higginsi, was formerly widespread in the St. Croix, Minnesota, and Mississippi (below the Twin Cities) Rivers. However, only one live specimen has been found since 1932 in the Mississippi River at Oquaqua, Illinois. In 1966 the survival of the species was considered threatened although several individuals have since been collected in Lake St. Croix at Hudson, Wisconsin.

ENDANGERED, THREATENED, AND LOCALLY RARE PLANTS AND ANIMALS

2.291 Several lists of threatened (or rare and endangered) plants and animals have been compiled. These lists include those prepared by the U.S. Department of the Interior and those prepared by various individual States These lists contain species protected legally and also other nonprotected species threatened by dangerously low population levels, habitat degradation, or over-exploitation. Species rare locally but not in adjacent States; i.e., species at the limit of their geographic range, are included in some lists. This inclusion serves to encourage maintenance of a broad genetic pool and helps insure survival of the entire species' population.

2.292 The variety of lists of endangered species is due to two difficulties which are encountered in compiling such a list. The first difficulty is the definition of an endangered species; i.e., at what population size, and under what environmental factors does a species' population become in danger of extinction. Secondly, there is a lack of specific information on the current population size and reproductive success of many species.

2.293 Animals. - For the purpose of discussion in this Environmental Impact Statement three categories of rare or endangered animals will be considered. These categories are:

a. "Endangered" - Those animals determined by the Secretary of the Interior to be threatened with extinction and named on the list which is published and amended periodically in the Federal Register (These animals are eligible for the benefits provided by the Endangered Species Conservation Act of 1969).

b. "Threatened" - Those species of animals listed under the U.S. Department of the Interior's resource publication No. 114, Threatened

Wildlife of the United States. This publication presents data on the status of species or subspecies of vertebrates whose existence is threatened in the United States and territories thereof. It is intended to be a reference for compiling the official list of endangered native fish and wildlife, as a means to stimulate interest, to impart knowledge, and to solicit information about threatened wildlife. The animals covered by data pages in this publication do not comprise the official list of "Endangered" species. The latter is found in the U.S. Department of the Interior's list of endangered native fish and wildlife, published in the Federal Register.

c. "Locally Rare" - Those species of animals that are locally rare or are in danger of being extirpated within the boundaries of a given area, but not necessarily in other locations. Animals included on a State list of "rare and endangered species" * but not included under the categories a and b above, will be considered as "locally rare."

2.294 Of the animals which occur in the Upper Mississippi River basin, two mammals and two birds are included on the "Endangered list" published in the latest Federal Register (see Exhibit 96). The timber wolf would probably not be found in the study area but the Indiana bat (*Myotis sodalis*), southern bald eagle (*Haliaetus leucocephalus leucocephalus*), and peregrine falcon (*Falco peregrinus*) are known to occur there.

2.295 The small Indiana myotis bat has not been identified within most pools. Because of its very small numbers and limits of its range to southern Wisconsin, it may not ever have been more than a rare visitor.

2.296 Birds on the endangered species list were sighted in the Upper Mississippi River valley in 1973. These include the southern bald eagle, a migrant sometimes sighted in the Upper Mississippi River, and the American peregrine falcon, once plentiful along the river but now seldom seen.

2.297 Included in the U.S. Department of the Interior's resource publication No. 114 titled "Threatened Wildlife of the United States" are one bird and one fish which occur in the Upper Mississippi River basin (see Exhibit 97). The northern greater prairie chicken *Tympanuchus cupido pinnatus*) was once rather common throughout Minnesota and Wisconsin, but it is absent from the project area today. The lake sturgeon (*Acipenser fulvescens*) is distributed throughout the Great Lakes drainage area with records from the Mississippi and St. Croix Rivers. The lake sturgeon has been netted in the St. Croix and

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* A State's lists of endangered species usually includes species protected under the laws of that particular State. Information concerning state lists of rare and endangered species can be obtained from the respective State resource agency.

occasionally one is caught by an angler. One species of clam (Lampsilis higginsi), is regarded as a threatened species by experts on clams and is included on the list of rare and endangered mollusks of the United States, as published by the U.S. Bureau of Sport Fisheries and Wildlife in 1972. This mussel is reported from the Hudson, Wisconsin, area of Lake St. Croix, which lies within the study area.

2.298 Exhibit 98 is a tentative listing of animals locally rare to the study area. There are several animals from this list noteworthy of special attention, as they are more likely to occur in the project area and therefore could be affected by operations and maintenance activities. These include: 1 mammal (the star-nose mole); 3 birds (the double-crested cormorant, the northern bald eagle, and the osprey); 2 reptiles (the false map turtle; the eastern massasauga) and 5 fish (the paddlefish, the river redhorse, the greater redhorse, the gilt darter, and the weed shiner).

2.299 The northern bald eagle, though not in a national endangered status, like the southern form, is subject, however, to the same forces that could decimate its numbers farther. Several concentration points exist where the northern bald eagle feeds and rests during its sojourn on the Upper Mississippi River. The southern bald eagle has been identified here by banding records.

2.300 Two particularly valuable feeding areas for bald eagles exist within the navigation pools of the St. Paul District. One is located along the stretch of river from the Alma Dam (L/D 4) to the foot of Lake Pepin. Here fish are available in the open water with the greatest concentration to be found in the immediate vicinity of the mouth of the Chippewa River. A second such area is in the Weaver Bottoms of pool 5. Early in the fall until freeze up, bald eagles also gather there, drawn by the number of wounded waterfowl that are concentrated in the area.

2.301 Double-crested cormorants formerly traversed the Mississippi Flyway in huge flocks during spring and fall migrations. Since the early 1960s, however, the numbers have dropped to a few sightings of very small flocks. The osprey has also declined markedly in numbers along the river over the past several years. There were nests recorded in the past but no nests have been seen here for many years. The most likely cause is reproductive failure due to pollutants such as DDT. The northern bald eagle, the osprey, and the double-crested cormorant are protected as endangered species under Wisconsin State Law.

2.302 Plants - A list of rare and endangered plants in Minnesota was compiled by the Minnesota Department of Natural Resources (MNDNR, 1971). This list contains a total of ten plant species, including five plants

found in moist prairies, three plants found in open hardwoods, and two plants found in the northern conifer forests (See Exhibit 99).

2.303 The Minnesota State Wildflower Law, which was passed in 1925 and revised in 1935, prohibits the sale of certain species of wildflowers and the picking or digging of them on public lands or on private lands without the written consent of the property owner (see Exhibit 100). This law is administered by the Minnesota Department of Agriculture.

2.304 Section 29546 of the Wisconsin statutes lists certain plant species as legally protected, including trillium, wood lilies, turk's-cap-lily, pitcher plant, purple-fringed orchid, ladyslipper orchid, trailing arbutus, American bittersweet, American lotus, members of the orchid family, and turks-cap.

2.305 T. Morley from the University of Minnesota compiled an extensive list of threatened plant species in 1972 which includes all species of the orchid family; all species of lily, trillium, and gentian; and trailing arbutus. A specific category in the list included those plants rare in Minnesota and all of North America, a total of four plants. One of these species, the Minnesota trout-lily or adder's tongue, is found nowhere else but in Minnesota (see Exhibit 101). Morley also included another special category containing 252 plants which are rare in Minnesota but are more or less abundant in adjacent regions.

2.306 Orchids which have been found in the Minnesota River valley could be adversely affected by spoil deposition in woodlands along the riverbank. The American Lotus (Nelumbo lutea) is found in Snelling Lake and is common in other floodplain lakes.

2.307 Studies of plants in the St. Croix valley have discovered two legally protected plants, turk's cap-lily and trillium, and two species which are threatened, a shrubby evergreen (Taxus canadensis or yew) and the prairie phlox. Three plants rare in Minnesota but more or less abundant in nearby areas, Quising, besseya, and narrow-leaved vervian, were also found in the valley.

SOCIOECONOMIC SETTING

HISTORICAL DEVELOPMENT OF THE WATERSHED

2.308 The Mississippi River has played and continues to play a significant part in the development of the communities in this area. Long before the coming of the first white settlers, it provided a transportation corridor for the Indians and for two hundred years it served as an avenue of commerce for the fur trade.

2.309 Early commercial traffic on the upper Mississippi River consisted primarily of small packet boats and log rafts. The invention of the

steamboat in the early nineteenth century brought about a revolution in river commerce. In April 1823, the steamboat Virginia left St. Louis, and 20 days and 800 miles later docked at Fort Snelling, Minnesota, at the confluence of the Minnesota and Mississippi Rivers, the first steamboat to make this trip. By 1830 the steamboat age had come to the Mississippi River, and by 1840 there was considerable river commerce between St. Louis and Minneapolis, Minnesota. The record shows that in 1859 more than 1,000 steamboats were in operation on the river.

2.310 During the decade 1850-1860, regular commercial traffic was extended to the Minnesota River where by 1865 stern-wheeled packet boats navigated on daily schedules serving river communities as far upstream as Fort Ridgely.

2.311 The period of reconstruction after the Civil War was the beginning of a flood of homesteaders into the Upper Mississippi River valley and the prairie country beyond. To lure the immigrants into the newly opened regions of the west, free, virgin land was the big inducement Farmers were not the only ones to rush into this new country, for many eastern business and professional men set up shops and services in the growing villages, most of which were at first located on navigable rivers.

2.312 By 1880, the difficulties of river transportation due to lack of channel improvements and the increasing competition of the railroads began to take their toll. River traffic declined. However, a logging boom which began in 1875 was responsible for a short-lived revival of freight traffic on the upper reaches of the river. A peak came in 1903 when 4.5 million tons moved between St. Paul and the mouth of the Missouri River. Thereafter, a rapid decline in river freight traffic coincided with a drop in use of the river for moving logs and lumber. In 1909, only 0.5 million tons were shipped on the upper reach of the river. A photograph depicting typical steamboat movement of a log raft around the turn of the century is shown on the following page.

View from Buena Vista Bluff at Alma, Wisconsin, taken in about 1900 and showing steamboats pushing log rafts downstream toward sawmills in Winona or some other lumber center. Photo courtesy of Winona County Historical Society.

2.313 Meanwhile, waterpower developments at St. Anthony Falls were a major factor in the industrial growth of Minneapolis during the latter half of the nineteenth century. The first commercial sawmill was built in 1847 and the first commercial flour mill in 1851, both water powered. In 1882, the first hydroelectric plant in the United States (and probably the first in the Western Hemisphere) was placed in service at St. Anthony Falls.

2.314 As the fur trading and eventually the lumber industry declined, agriculture and dairying became the leading industries. This development was made possible by large areas of highly productive soils and a favorable climate. Today, Wisconsin is the nation's leader in income from dairy products, while Minnesota is first in the raising of oats, second in hay, and fourth in dairying. Iowa is the nation's

number one producer of corn and second in soybeans and fifth in oats. Forest products still make a substantial contribution to the economy of the Upper Mississippi River basin. Lumber, veneer, pulpwood, paper, railroad ties, and Christmas trees are the principal products. Water-oriented outdoor recreation such as fishing, hunting, boating, and camping, is the basis for a thriving tourist industry in much of the basin.

2.315 As the population and industry of the upper midwest region grew, there was a corresponding growth in the need for cheap coal for power generation. A technological consequence of this need was the development of the barge and towboat which gradually replaced the steamboat on the river. The need for coal in the upper midwest was complemented by the need to ship large quantities of grain south to other population centers.

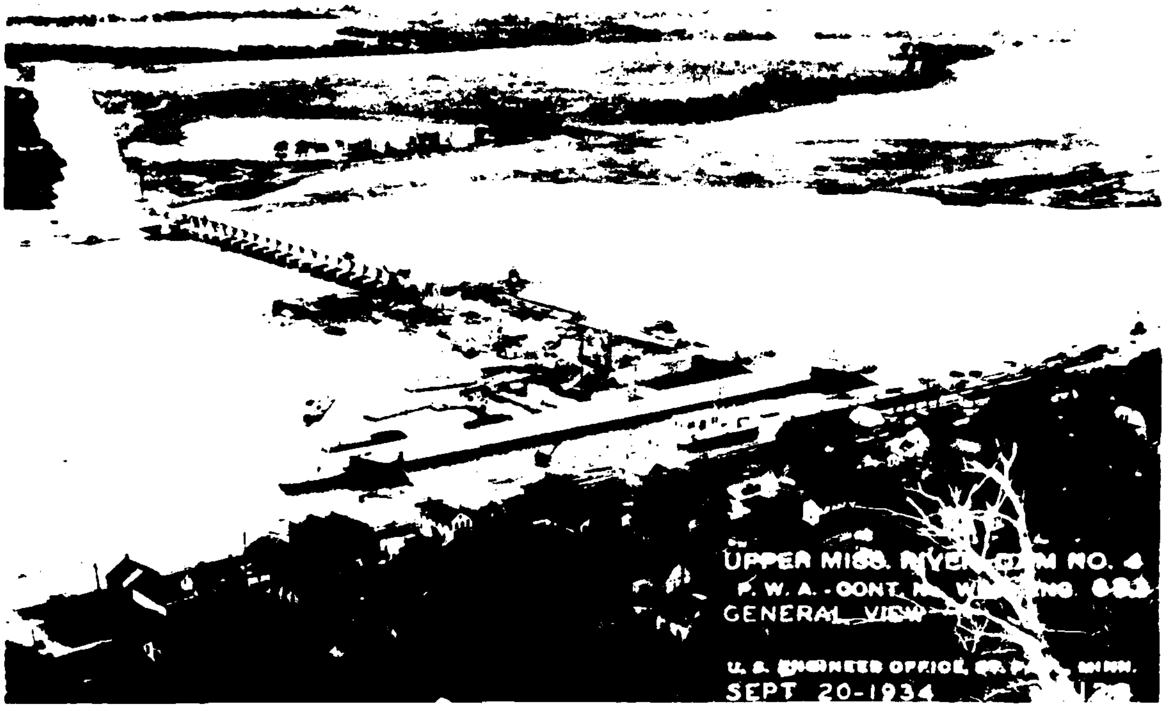
2.316 Economies could be realized by having at least partially compensating cargoes going both directions. The period of World War I marked the beginning of the rebirth of waterborne commerce and large grain shipments from Minneapolis began in the late 1920s. Recognition of the role of the river in the transportation network of the U. S. led to the authorization of a 9-foot channel to Minneapolis in 1930.

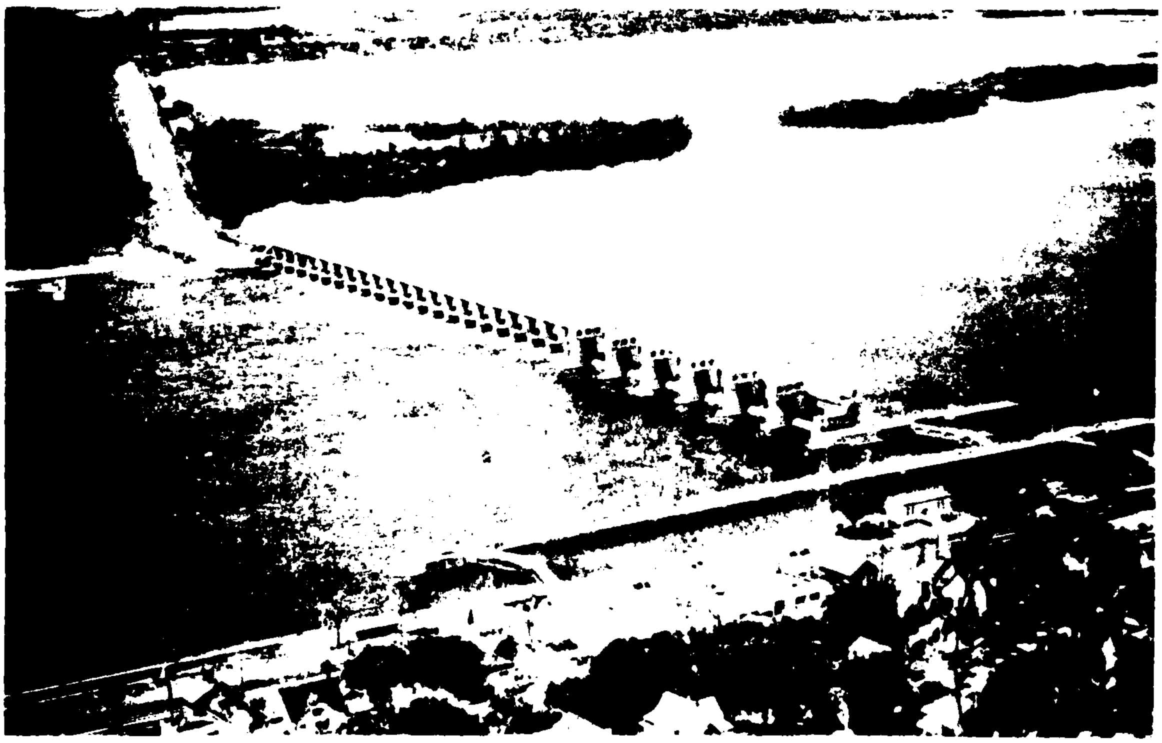
2.317 Most of the 29 locks and dams necessary for the 9-foot channel project were constructed during the 1930s. The photographs on the following page show lock and dam 4 during construction and as it appears now. Lock and dam No. 19 at Keokuk, Iowa, was constructed as part of a hydroelectric facility in 1914, while lock and dam No. 1 located at river mile 847.6 was completed in 1917 as part of the 6-foot channel project. It was rebuilt in 1930 to accommodate 9-foot draft water craft.

2.318 The newest of the 29 structures on the Mississippi River constructed to maintain the 9-foot channel are the upper and lower locks and the lower dam at St. Anthony Falls. The lower lock was opened to navigation in 1959, the upper in 1963.

THE 9-FOOT CHANNEL CONTROVERSY

2.319 The River and Harbor Act of 1930, which authorized the Corps of Engineers to modify the obsolete 6-foot channel to provide a minimum depth of 9 feet and a minimum width of 300 feet, was preceded by considerable controversy along the river.





The upper photograph shows Lock and Dam 4 during construction with its pool not filled. The lower photograph shows the completed dam and the filled pool in 1973.

Two reasons were generally referred to by those favoring the 9-foot channelization project: national defense and national economic growth and progress. The defense arguments for the dam system were summarized by Halleck W. Seaman of Clinton in an address before the Rotary Club at Davenport, Iowa in 1930:

> "Should this country be attacked by a coalition of two or more first-class European powers, with Japan in the Pacific, and should they break through our naval defenses on either one or both of our ocean coasts, then by falling back upon the Mississippi our forces could hold indefinitely and bid defiance to the world. We could starve out an invading enemy."

But this would only be possible, he argued, if the river were easily navigable for the transport of food, arms, and other supplies.

2.320 Supporting arguments based upon the notion of facilitating economic growth and progress were most often cited by the proponents of the system. The river traffic firms were interested in seeing the project completed, and, of course, the anticipated lower transportation costs appealed to most industries along the river as well as to many farmers and other shippers. Immense tonnage could be moved if huge barge tows were able to more easily navigate the river. Arguing specifically for the concerns of farmers, U. S. Congressman Goodwin of Minnesota stated:

> "The 9-foot channel would equalize the competition between our inland states and the agricultural regions of other countries that are more advantageously located near the ocean. Therefore, the completion of this project will be, in my opinion, the source of relief to agriculture, which will equal, if not surpass, any legislation relief heretofore applied to agriculture."

2.321 Beyond the reasons of national defense and national economic growth and progress, there were a few area-specific arguments advanced for the lock and dam system. One of these was the immediate employment benefits of the construction projects. Many of the areas along the river had large portions of unemployed population, and the jobs that would be available in all phases of project construction were a strong argument to a depressed area.

2.322 Another reason advanced for support of the project was the specific benefits which would come to the cities along the river. The dream was that the increased commerce would make these towns boom with expanding industry.

2.323 Fourth District U. S. Congressman Fred Biermann of Decorah, Iowa, who was first elected with the Democratic landslide of 1932, was ardent in his opposition to the project. A summary of his opinion provides a sketch of the basis for local opposition. Biermann claimed that the

locks and dams would destroy the scenic beauty of the river, and for no good purpose. He saw the previous alterations of the river channel to 4½ and 6 feet as failures and expected the same of the 9-foot project. The losses of land by area farmers as a result of the anticipated deepening and widening of the river were another source of contention (Allamakee Journal, 1933). The railroads, who opposed the project, gained Congressman Biermann's support.

2.324 In numerous pronouncements, the Izaac Walton League of America also condemned the 9-foot channel plan as detrimental to the environment. The League was especially concerned that erosion and pollution be controlled before the project was begun.

2.325 Writers of outdoor columns in newspapers were vocal in condemning the project. For example, the Voice of the Outdoors (Winona Republican Herald, July 26, 1930) stated:

> "We are still against the alleged 9-foot channel under the dam form of construction. We are now more firmly convinced than ever that it will be a gigantic commercial failure and will be impossible to maintain without spending millions of dollars each year in dredging operations. It will completely destroy bass fishing on the river and will form a series of badly polluted pools that will look like a lot of link sausages on a map and smell worse than said sausage if they were left exposed to the present heat for a week. The scenic attraction of the river will be completely wiped out."

2.326 Many observers expressed concern that soil erosion would constitute a severe problem in the proposed navigation pools. C. G. Bates, a forestry engineer, was quoted by the Voice of the Outdoors (Winona Republican Herald, July 23, 1930) as predicting that the proposed pools would be completely filled with sand in a period of 20 years.

2.327 The U. S. Bureau of Fisheries viewed the 9-foot channel project with serious misgivings. The following are direct quotes from the Bureau's written testimony presented at a hearing in Wabasha (Culler, 1931):

> "The Bureau of Fisheries views with much concern the establishment of a series of slack water pools along the Upper Mississippi River until the problem of pollution and erosion as they affect this upper section of the Mississippi River are solved. If the lake formed by the Keokuk Dam may be taken as a criterion, the creation of similar pools may mean the eventual elimination of all fish life inasmuch as the production of fish in Lake Cooper, which is formed by the Keokuk Dam, has declined according to the official statistics of the Bureau of Fisheries from 701,181 pounds in 1922 to 350,750 pounds in 1929.

The construction of slack water pools such as the one that is contemplated at this time and in this particular section north of Winona, will mean the eventual elimination of the smallmouth black bass for which this section is so widely known."

2.328 The U. S. Bureau of Biological Survey (Henderson,1931) reported on the other hand, that the 9-foot channel project could be beneficial to waterfowl and muskrats if water levels were stabilized. The Bureau's conclusions were based on a comprehensive study of the biological effects of lock and dam No. 19 on the Mississippi River. The following is a direct quote from Henderson's report:

"It is very probable that considerable portions of the Upper Mississippi River Wildlife and Fish Refuge would be benefited by the construction level above a maximum of 5 feet in depth over the newly flooded bottomlands, provided that stable water levels are maintained throughout the year. The construction of these dams will undoubtedly make an entirely different type of refuge, for most of the bottomland timber will be destroyed and the percentage of land unaffected by the flooding will be relatively small. Immediately following the construction of any system of dams flooding the lowlands, an adverse period must be anticipated, but following the readjustment and reestablishment of the aquatic and marsh vegetation, the refuge should be an improved place for waterfowl and probably also for muskrats."

2.329 To a degree, the 9-foot channel controversy continues into the present. In many ways the project has fulfilled the optimistic expectations of those who viewed it as an economic asset both locally and on the wider regional or even national basis. It is true as is evident in the discussions to follow that the economic benefits have been rather unevenly distributed and that communities in the southern pools of the District, pool 9 for example, have benefited less than those in the northern pools. Still, the increase in barge traffic and tonnage moved on the river gives a general indication of economic success of the project.

2.330 Effects of the original project on the natural environment were discussed under a previous heading. The 9-foot channel controversy continues to the extent these effects are still subjects of debate. But also in the socioeconomic area, there are still areas of disagreement. What, for example, has the project done to archaeological and historic sites on the river? How has it affected commercial fishing and trapping, pleasure boating, sport fishing, and hunting, and recreation in general? These and other topics are discussed below incidental to a description of the current setting.

ARCHAEOLOGICAL, HISTORIC AND SCIENTIFIC SITES

2.331 Archaeological and historic sites of importance consist of such diverse elements as prehistoric village sites, petroglyphs (rock pictures), burial mounds, log cabins, forts, and so forth. Sites of significance may date from thousands of years ago to very recent times. Interest in studying elements of human history also varies as much with the times as interest in studying elements of natural history.

2.332 The difficulty in identifying archaeological and historical sites is not the absence of records of significant sites, but rather that records of thousands exist. Although archaeologists have resurveyed some of them, vast areas have not been checked since the original 19th century surveys. The farmer, in the course of clearing and farming his land, is largely responsible for the destruction of the sites, and most of those identified by early archaeologists have by now been destroyed.

2.333 Minnesota - Plans were made to provide an inventory of Minnesota archaeological sites which lie in the study area. This idea was abandoned, however, due to the following considerations:

a. The number of sites in close proximity to the river is large and the amount of work required to review existing records (beginning in the early 1800s) exceeds the value of such an inventory in this report.

b. The records are known to be incomplete in many cases, scanty for certain areas,or incorrect so that reliability of the inventory is questionable.

c. Many recorded sites have been destroyed but the records have never been updated, nor has there even been a complete systematic inventory of archaeological sites in Minnesota.

d. In many cases the location of sites given is not sufficiently accurate to determine if the site is close enough to the riverbank to be threatened. In some cases, where the bluffs are close to the riverbed, a vertical elevation of many feet may effectively remove a site from any threats by water, dredge spoil, or construction. The records may not show this.

e. The Minnesota State Archaeologist is understandably reluctant to publish a list or inventory of archaeological sites because of risk of robbery, despoilation, vandalism, or unauthorized unscientific excavation. Such cases have been known in the past. However, the State Archaeologist and his staff have expressed the willingness and desire to assist individuals or government bodies in locating and identifying sites for preservation or

excavation before destruction. Recovery attempts of data and/or artifacts could be pursued prior to dredging or authorization of a permit.

2.334 A consultant's report based on research in the files of the Minnesota State Archaeologist has been summarized below. The complete text may be consulted in the Environmental Assessment Reports referred to in the Foreword of this statement.

2.335 There are approximately 85 designated sites in the Corps of Engineers area under consideration (i.e., the Mississippi River from St. Anthony Falls to the Minnesota-Iowa border, the Minnesota River from Shakopee to Pike Island, and the St. Croix from above Stillwater to Prescott). The information on these sites has been collected since the late 1800s and all the data are filed in the Archaeology Laboratory at the University of Minnesota.

2.336 For this statement archaeological sites in Minnesota can be categorized into 3 main groups as follows:

a. Group I. Sites definitely known to have been destroyed by Corps of Engineers activities. There are nine such sites.

b. Group II. Sites in the area under consideration which should not be affected by the Corps because they appear too high above the river channels. There are six of these sites.

c. Group III. The largest group of sites (73) near to the river and within the Corps of Engineers area (Minnesota). This is the group for which no definite classification can be given. There are many reasons:

(1) Site location description is too vague to determine if the site is or was in danger.

(2) Sites which were destroyed, such as the mound groups at Dresbach, but where it cannot be determined if the sites were destroyed by the Corps of Engineers dam construction or by some unrelated factors.

(3) Sites, such as those on Pig's Eye Island, which have not been reexamined since recorded but are so located as to be affected by a fluctuation in the river level or by erosion. Any dredging of the river and subsequent depositing of the debris on the nearby shore would undoubtedly cover such sites.

2.337 The following chart is a breakdown by pool of archaeological sites in Minnesota affected by the Corps of Engineers. The sites are listed using the groupings defined above.

Pool #	Group #1 (destroyed)	Group #2 (not affected)	Group #3 (uncertain)
2	2	1	7
3	4	2	11
4	0	1	7
5	1	0	1
5 or 5A	2	0	3
6	0	0	1
7	0	0	7
8	0	0	6
St. Croix	0	0	5
Minnesota	0	2	25
	9	6	73

2.338 More specific information, particularly on archaeological sites in Minnesota which have been destroyed is contained in Exhibit 102. They are also identified in the Socioeconomic Factors Pool By Pool subsection.

2.339 Wisconsin - A review of the publications reveals that Wisconsin archaeological and historic sites, especially burial mounds, were extensive. The mounds in Wisconsin were estimated to number 15,000. Sites occurred on and near the shores of nearly every stream and lake. In addition to burial mounds, sites of native villages, camps and workshops; plots of corn hills and garden beds; enclosures, burial places and cemeteries; refuse heaps and pits; cave shelters; shrines; pictograph rocks; boulder mortars, sources of flint, quartz, quartzite,and pipestone; lead diggings; copper mining pits; stone heaps and circles; cairns; and trails are of interest to the Wisconsin archaeologist. Burial mounds, village sites, forts, and pictographs are found in the Mississippi River valley.

2.340 Specific sites have been flooded on Lake Pepin, at Trempealeau and at Wyalusing. An examination of the Wisconsin Archaeologist's files of the historical society and on site visits would be required before one could be assured of an accurate description of the sites. One Wisconsin historic and archaeological site borders the Mississippi. This is on St. Feriole Island in the Mississippi River at Prairie du Chien.

2.341 Currently, the only scientific area designated within the river corridor is the Nelson Trevino Bottoms. Numerous other scientific areas have been designated as potential areas, particularly by the Wisconsin Scientific Area Preservation Council, but they are either removed from the river corridor or not officially so designated. For example, areas presently under consideration include Bertom Lake, Turtle Island, Black River Bottoms, and the Kinnickinnic River Delta.

2.342 Iowa - Particularly significant for the Iowa stretch of the river are numerous burial mounds. These are discussed in pools 9 and 10 descriptions below. Again, only by checking the site locations filed in the Archaeological Laboratory, University of Iowa, Iowa City, and by on-site inspections could one determine exactly how many sites are, or were, found along the river flats.

AREA POPULATION AND INCOME

2.343 The St. Paul District's portion of the basin of the Upper Mississippi River includes almost all of Minnesota, the western half of Wisconsin and a small section of northeastern Iowa and northeastern South Dakota. The basin extends 360 miles east and west and about 330 miles north and south. The population of the Mississippi River basin in the St. Paul District is approximately 4.1 million. The Twin Cities, Minneapolis and St. Paul, are the largest urban centers and, including their suburbs, they have a population of well over 1.8 million. Per capita income in the metropolitan area was $3,440 in 1969. This metropolitan area is served by 10 railroads and is well situated as a midwest distribution and manufacturing center for commodities of every description. Long famed as a flour-milling and food-processing center, the area has now also become a leading producer of many kinds of machinery.

2.344 Except for the heavy concentration of population in the cities of St. Paul; Minneapolis; Winona, Minnesota; and La Crosse, Wisconsin, the population in the project area is dispersed in the surrounding farming country. Small towns and villages are scattered along the rivers and throughout the hinterland. The population in the primary zone lying within 50 miles on each side of the river is about 2.2 million and the population within 100 miles of the river is about 3 million. Many people living within 50 miles are attracted to the river and others travel a distance of 100 miles or more for a 1-day trip to the river.

2.345 Downstream, only La Crosse, Wisconsin, adjacent to pool 8, had a population exceeding 50,000 (51,153) in 1970. In the greater La Crosse area, in 1966, 22,403 individuals were employed in manufacturing, 19,368 in agriculture, and 19,010 in wholesale and retail enterprises. The per capita income in the La Crosse area was $2,715 in 1969. The next largest community in the study area downstream from the Twin Cities is Winona, Minnesota, adjacent to pool 6, with a population in 1970 of 27,438. The 1970 census recorded a number of river communities with populations of around 10,000. Hastings, Minnesota, at lock and dam No. 2 had a population of 12,195. Red Wing, Minnesota, on pool 4 at the head of Lake Pepin had 10,441 inhabitants while Stillwater, Minnesota, just below the head of the 9-foot navigation channel on the St. Croix River, had 10,191. Prairie du Chien, Wisconsin, at pool 9 had 5,540 inhabitants in 1970 and Guttenberg, Iowa, at the downstream end of the St. Paul District had 2,177. Still smaller communities such as Lansing, Iowa (1,218) and Fountain City, Wisconsin (1,017) had populations of around 1,000. Population data for urban areas

and for counties in the St. Paul District along with projections to the year 2200 appear in Exhibit 103.

AGRICULTURAL LAND USE

2.346 Today the study area is predominantly an agricultural one, for of the 50 million acres in the Upper Mississippi basin, 26 million are devoted to some form of agricultural purposes. The 1969 value of crops sold was approximately 900 million dollars, and livestock (including dairy products) sold for approximately 2 billion dollars.

2.346 Man's land use patterns in the watershed of the Upper Mississippi River have accelerated the relentless erosion of the land. Contour farming and strip cropping were not begun in the area until the late 1930s. As a consequence, early farming practices were extremely destructive to the land. Farming was done, in the early days, with little care given to the precipitous hillsides. Conservation, to the early farmers, meant getting the most use out of every piece of land that they owned. Consequently, they plowed land that should not have been plowed. Hillsides that were too steep to be plowed were burned, grazed, and logged. Floods in tributary valleys were extremely common at all seasons of the year and alluvium from the uplands caused the aggradation of most valley floors. This aggradation can be easily proved by examining buried soil profiles exhibited in the cut banks of valley streams. Entire valley communities were slowly inundated, in some instances by sand and silt from the uplands. Much of the alluvium from tributary valleys ultimately was washed into the mainstream of the Mississippi River. Even today, the watershed is severely abused by agricultural practices. Steep slopes, in most areas, are still plowed and grazed. The fragile sand terraces of the Chippewa River, for example, are still grazed to the water's edge.

FEDERAL AND OTHER LANDS

2.347 There are a total of 237,792 acres of federally-owned land and water area in the various pools. Some 67,130 acres of this total is above normal water level. Of this figure 25,445 acres are under the jurisdiction of the Corps of Engineers. Most of this land has been made available to the Bureau of Sport Fisheries and Wildlife, Department of the Interior, for wildlife refuge. The Corps-administered lands under permit to the Bureau of Sport Fisheries and Wildlife are now operated and managed together with Bureau-owned lands as the Upper Mississippi River Wildlife and Fish Refuge. The Bureau has jurisdiction over refuge waterfowl and furbearing animals and designates sanctuaries and open areas. The refuge, with an interspersion of closed and open areas, makes the river valley particularly attractive for hunting and fishing in much of the project area.

Sheet erosion of row-crops in Pierce County, Wisconsin.

The type of contour cropping practiced on few farms, but necessary on almost all farms in the Pierce County watersheds bordering the Mississippi River.

2.348 The National Park Service has established one national park in the immediate vicinity of the project. This park, Effigy Mounds National Monument, was established in 1949, near McGregor, Iowa, and is located in the vicinity of pool 10. The park contains 1,244 acres of land, much of which contains prehistoric Indian mounds. Annual attendance has increased rapidly from year to year. Minimal facilities are provided for water-associated activities but the park attracts many people to the area. There is a southern extension of Effigy Mounds Monument at Sny Macgill Creek. The site is undeveloped but offers river access through Sny Macgill Landing operated by the Iowa Conservation Department.

2.349 Five Minnesota State parks bordering the project area are currently in operation: Frontenac and John A. Latsch on the Mississippi River, Interstate and William O'Brien on the St. Croix River, and Fort Snelling at the confluence of the Mississippi and Minnesota Rivers. The parks attract many visitors annually and provide a variety of outdoor activities. However, no facilities are available for water-based recreation activities. A total of 3,915 acres of Corps-administered land has been licensed to the Minnesota Department of Natural Resources which is managed, together with the State-owned Gores tract of 1,187 acres, as the Gores Pool 3 Wildlife Area.

2.350 Five Wisconsin State parks border on the project area and attract many visitors annually. These parks are Merrick, Perrot and Wyalusing on the Mississippi River, and Interstate and Kinnikinnick River State Park on the St. Croix River.

2.351 Pikes Peak State Park lies adjacent to the pool 10 area and is the only Iowa State Park located in the St. Paul District portion of the project area. The park provides day-use and camping facilities but has no facilities for water access or water-associated activities.

WATERBORNE COMMERCE

2.352 Since 1940 when the 9-foot channel had been placed in operation, river traffic increased rapidly. The table below shows tonnage information available for selected years from 1920 through 1945 for the river segment identified in the third column of the table.

Year	Total Tonnage (short tons) Shipments and Receipts*	River Segment
1920	630,951	Mpls. to mouth of Missouri River
1925	908,005	Mpls. to mouth of Missouri River
1926	691,637	Mpls. to mouth of Missouri River
1927	715,110	Mpls. to mouth of Missouri River
1928	21,632	Mpls. to mouth of Wisconsin River
1929	1,390,262	Mpls. to mouth of Ohio River
1930	1,395,855	Mpls. to mouth of Ohio River
1935	188,613	St. Paul District
1940	1,097,971	St. Paul District
1945	1,263,993	St. Paul District

* Tonnages exclude ferry freight (cars and other) and certain cargoes-transit.

2.353 Certain industries, dependent upon the growing barge traffic for their economic viability began locating on industrial sites along the river. The investment which they represent and the employment they generate are also attributable to the 9-foot channel project. Connected with this physical evidence of the project is the human impact, perhaps best expressed in the employment which facilities and vessels provide.

2.354 Exhibits 104 and 105 show graphically the growth of receipts into and shipments from the St. Paul District in the 30 years from 1940 to 1970. Although receipts still substantially exceed shipments, the growth in shipments (89 percent grain) from the district in these three decades indicates the great impact of the river on the regional economy. Projected commerce in the Upper Mississippi River basin is illustrated in Exhibit 106.

2.355 It is noteworthy that receipts into the St. Paul District have always exceeded shipments. In earlier years this imbalance was often extreme (e.g., 1953 receipts, 3,052,144 tons; shipments, 334,233 tons). Recently, however, the ratio has been around 2 to 1. Inasmuch as grains as soybeans constitute the preponderant tonnage of shipments, fluctuation in waterborne transport of these products can be profound because of crop conditions and storage facilities, foreign sales, and competing forms of transportation.

2.356 An idea of more recent shipping activity can be gained from the following tabulation which shows the movement of tonnage through the St. Paul District for the years 1962 through 1972.

Year	Total Traffic St. Paul District
1962	8,168,594 tons
1963	9,266,361
1964	9,621,336
1965	9,205,538
1966	11,346,457
1967	11,618,849
1968	10,736,350
1969	12,647,428
1970	15,423,713
1971	15,070,082
1972	16,361,174

2.357 When this table is compared with the previous one, the growth of shipping on the Upper Mississippi River becomes readily apparent. Thus, the total traffic for the St. Paul District in 1962 was about six times the traffic in 1945, which was a war year. In fact, traffic in the St. Paul District for 1962 was more than five times greater than all of the traffic on the Upper Mississippi River between Minneapolis and the mouth of the Ohio River in 1930. Traffic about doubled in the St. Paul District between 1962 and 1971. This was due in a large degree to grain shipments from the District and to an increase in receipts of coal.

2.358 The navigable rivers maintained and operated by the St. Paul District should be viewed within the context of the total system including the Mississippi, Ohio, Missouri, and other tributary rivers. In 1964, a detailed analysis of the origin-destination waterborne commerce traffic patterns showed that the average miles per ton on the Upper Mississippi River Waterway System ranged from 700 to 800 miles. This indicates that the great bulk of shipments and receipts have origins or destinations outside the St. Paul District. In addition to its own shipments and receipts each pool contributes to the economic benefits enjoyed by the system as a whole. Thus, any measure of the economic benefits of the river commerce on an individual pool basis must include the benefits that it contributes as a necessary link in the Upper Mississippi River system.

2.359 A further benefit which can be attributed to the maintenance of navigation on the Upper Mississippi River is in the savings in transportation costs, particularly for bulk commodities. Estimates of these cost savings have been made based upon comparisons of rates for the least-cost alternatives. One of these estimates, the savings over the other various least cost alternatives, is between 4.0 and 5.4 mills per ton-mile.* It is generally recognized that bulk commodities, particularly those having low value-to-weight ratios, are appropriate for barge transport. Coal, petroleum, and grain have these characteristics and are examples of such commodities that move on the Upper Mississippi River and its navigable tributaries.

2.360 Firms that depend heavily on the river often maintain riverside facilities. The Upper Mississippi River and its navigable tributaries contain approximately 89 commercial docks and terminals, shipping and receiving a wide variety of products. Behind many of these docks are the farms, factories, storage facilities, and refineries which are dependent upon them at the present time. Thus, the ramifications of river navigation reach deeply into the entire economy of the entire Upper Mississippi River region. Employment directly and indirectly connected

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* Appendix J, Upper Mississippi River Comprehensive Basin Study, 1970

to these industries forms a small though significant percentage of the regional work force. The Upper Mississippi River waterway is part of a highly integrated transportation system which serves to link the upper midwest with the rest of the country and the world. Railroads, highways, pipelines, and airlines all service the region in addition to the waterway, each mode of service either competing with and/or complementing the waterway to various degrees in the movement of products into and out of the region.

2.361 The socioeconomic impact of environmentally degrading effects due to commercial navigation cannot be measured precisely because of the inability to isolate single factors from a wide range of unquantifiable potential ones. Dredging and the movement of tugs and barges does increase water turbidity and wakes from rapidly moving craft contribute to bank erosion and recreational annoyance. Pollution from barge spillage and cleaning contributes to river pollution but is probably minor relative to the pollution load placed in the river from other sources such as the metropolitan areas.

COMMERCIAL FISHING AND TRAPPING*

2.362 As population along the northern section of the Mississippi River increased, industrial specialization also took place. The result was the development and growth of commercial fishing and trapping along the Upper Mississippi River in the last half of the nineteenth and during the twentieth century. The establishment of navigation pools after 1930 increased marsh development and provided more fish and fur animal habitat over that existing prior to the construction of the locks and dams.

2.363 On the northern section of the Upper Mississippi River, commercial production is carried on from lock and dam 10 through pool 2 above Hastings, Minnesota, a distance of about 209 river miles. On the main stem Mississippi River, little commercial fishing is reported between the head of navigation and Spring Lake in pool 2.

2.364 The most productive reaches of the river in terms of total pounds landed are Lake Pepin (pools 4 and 4A), and pools 8, 9, and 10. Landings in Lake Pepin from 1958 to 1965 averaged 1,967,000 pounds or 50.7 pounds per acre. Landings in pool 9 over the same period were 1,410,000 pounds or 45.6 pounds per acre. Over the same period total landings on the Mississippi River from St. Louis to St. Paul averaged 11,500,000 pounds or 28.7 pounds per acre.

2.365 Over the years, records of total landings in the Upper Mississippi River have remained relatively stable, and contrary to other inland fisheries, production in recent years has actually risen (Exhibit 107c). From 1950 to 1957, landings averaged 8.2 million pounds in contrast to

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* The information in this subsection was taken from the Upper Mississippi River Comprehensive Basin Study, Vol. VI, Appendix L.

an average of 11.5 million pounds between 1958 and 1965. The reported harvest in 1964 of almost 13.5 million pounds was the highest on record.

2.366 No major shifts in species composition of the commercial catch on the Mississippi River are apparent. The same four species, carp, buffalo fish, catfish and freshwater drum have continued to dominate the fishery and in approximately the same proportion after the initial upsurge of carp in 1899. Carp production in 1964 of 6.8 million pounds was exceeded only in 1922 and possibly several earlier years where data are incomplete. During the late 1950s and early 1960s some concern was expressed over a possible decline in the availability of catfish, but landings in 1964 increased to a point above the historical average. Whether or not this increase is temporary and a long-range trend of catfish decline has begun, remains to be seen. Since catfish currently represent almost one-half of the income of the fishery, its decline would be a serious blow to the industry.

2.367 On the Mississippi River in 1965 carp accounted for 50 percent of the landings, buffalo fish, 18 percent; catfish, 16 percent; and freshwater drum, 11 percent. Together, these four species represented 95.4 percent of river landings. This percentage has remained relatively constant over the years of record. In 1922, the four species accounted for 93 percent of the river landings. Other species of minor importance include paddlefish, suckers, shovelnose sturgeon, garfish and bowfin.

2.368 Production on the Mississippi River varies seasonally according to species, although total landings are relatively constant throughout the year. Data for the Wisconsin portion of the river for 1964 (pools 3 through 10) indicate peak carp production occurred from June through September; buffalo fish, from November through April; and catfish from May through September. Monthly drum landings were fairly stable through the year. In terms of gear, set lines were fished from May through September; gill nets, from December through April; and seines from March through November.

2.369 Landings and value of the Upper Mississippi basin commercial fishery exceeded those of any other basin or any one of the United States Great Lakes in 1964. Excluding mussel shell production, landings of 27 million pounds accounted for 40 percent of commercial freshwater fishery production outside of the Great Lakes and 27 percent of total value. Production of carp in the basin provided 49 percent of the carp landed in the United States in 1964.

2.370 The rivers of the basin accounted for 55 percent of total production in 1965, while 45 percent was derived from basin lakes. The Mississippi River proper was the primary producing unit in terms of pounds landed, value of the catch, and number of fishermen employed. The river fishery provided 44 percent of total landings and 61 percent of total value. The 25 largest units of production in 1965, including the Mississippi, St. Croix, Illinois and Rock Rivers and the 21 lakes with landings exceeding 100,000 pounds accounted for 78 percent of the basin landings.

2.371 A sampling of contract fishermen in Minnesota indicated that 75 percent of the landings were sold as food fish, 20 percent for animal feed and 5 percent live sales to pay lakes.

2.372 In Wisconsin in 1966, 50 percent of the carp sold from state removal operations went for animal feed, 28 percent as food fish and 22 percent live to fee ponds. Some 94 percent of buffalo fish sales went to food fish markets. Of the fish landed in the Minnesota and Wisconsin removal programs, 8 to 10 percent are discarded; the discard percentage is believed to be considerably higher in Iowa.

2.373 The primary market for carp continues to be in the larger eastern cities, particularly metropolitan New York. An estimated 8 to 10 million pounds are sold annually to this market. The bulk of the shipments originate from a few large processors or wholesalers in the basin but some direct sales are also made. Carp sales outside the basin are also made in southern cities and a winter market is available in the Florida resort areas. In addition to fresh and filleted forms, carp is smoked for local sales.

2.374 Buffalo fish and catfish are in considerably greater local demand than carp and are sold largely within the basin in fresh form. In recent years the demand for catfish has been very good and prices paid at the fisherman level have seldom been lower than 20 cents per pound. Most wholesalers in the Midwest have been unable to meet market demands with the available supply of catfish. Demand for buffalo fish has also been good relative to carp, although there appears to be a definite ceiling on the quantity of buffalo fish that can be placed on the market without producing price declines.

2.375 Freshwater drum is also sold fresh but some quantities are processed for mink feed. The drum of the Mississippi River and certain of the inland lakes are considered to be of better quality than those of the Great Lakes and consequently bring up to five cents more to the river fishermen. The flesh of river drum is usually characterized as "soft meat," while that of the Great Lakes fish is called "hard meat." Bullheads are sold fresh to some degree, but many are also sold live to fee ponds for sport fishing.

Live sales of bullheads represent a large part of bullhead production from the inland lakes.

2.376 The average price received for all species by fishermen on the Mississippi River in 1964 was 8.4 cents per pound. Average values by species were: carp, 3.3 cents; catfish, 23 cents; buffalo fish, 10.3 cents; and drum, 6.4 cents. Carp, while making up over 50 percent of the river landings, accounted for only 20 percent of total value. Catfish, with 17 percent of the landings, accounted for almost 48 percent of total value. Buffalo fish represented 18 percent of landings and 22 percent of value.

2.377 Prices for the major species landed in the basin have declined considerably since 1950 following the pattern of most of the U.S. freshwater fisheries, although some upturn for certain species was evident in 1965. As Exhibit 107d indicates, the range of wholesale carp prices on the Chicago market from 1957 to 1965 showed a definite downtrend for all grades. In addition, for medium graded carp (2-4 lbs.) no market existed in 1965 during the months of January through August, while in 1957 mediums were in demand throughout the 12-month period. Particularly for the fishery of the inland lakes where the haul seine is relatively nonselective as to size, the weakening of prices for the smaller-sized carp would have important effects on the profitability of these operations. In addition, intensive levels of removal over a period of years typically reduces the population to smaller individuals with correspondingly lower marketability for food fish. The effects of carp prices are also evident on the Mississippi River. For example, in 1955, carp landings for Wisconsin fishermen were 2.7 million pounds valued at $165,000, while in 1964 landings of 4.1 million pounds were valued at only $123,000.

2.378 Whilesale prices paid for catfish and bullheads on the Chicago market are essentially the same or perhaps a cent or two higher than in 1957. In 1965, catfish brought 47-58 cents (dressed and skinned), while bullheads dressed and skinned (large) ranged from 27-36 cents.

2.379 The range of buffalo fish prices has declined from 10-28 cents in 1957 to 7-24 cents in 1965. Drum prices in 1965 were similar to those in 1957, reversing a downtrend that reached its lowest point in 1964.

2.380 To the extent that water quality and other environmental factors affect commercial fishery landings, a survey of licensed commercial fishermen on the Mississippi conducted by the Wisconsin Conservation Department in 1961 indicated that these fishermen observed little recent adverse change in water quality in that section of the river. In the survey, fishermen were asked to indicate for each of seven species whether the quality of fishing was better, poorer or the same as that of 10 years ago (1950). Eighty percent or more of the respondents believed the quality of fishing was the same or better for channel catfish, carp, freshwater drum and bullheads, 79 percent for buffalo fish, 73 percent for shovelnose

sturgeon and 66 percent for flathead catfish.

2.381 The sport and commercial fishery has also been limited in the upper reaches of the river from the Twin Cities, downstream through pool 2 at Hastings, Minnesota. The Minnesota Department of Conservation has described conditions in the river in a statement prepared for a conference on Pollution of the Upper Mississippi, held in St. Paul in 1964.

2.382 Both sport and commercial fishermen have been active upstream in pool 2, but fishing pressure and catches are heavier in pools 3 and 4 downstream. Fish kills have been reported more often in pool 2 and these have been associated with low levels of dissolved oxygen attributable to pollution.

2.383 The commercial fishery in pools 2, 3, 4, and 4A, and 5 averaged 2.5 million pounds from 1958 to 1962, valued at slightly less than $100,000. The commercial catch in pool 2 is caught primarily in Spring Lake, and over the same period averaged 28 pounds per acre. However, major problems are encountered in Spring Lake from frequent off-flavor qualities of the catch which have reduced selling prices and forced buyers to place fish in holding ponds until the off-flavor has disappeared. Fish caught below pool 2 are not known to have these characteristics.

2.384 Aside from the reach of Minneapolis-St. Paul to Hastings, water quality on the Upper Mississippi River is generally good. At the same time the critical water quality factors affecting commercial production are not necessarily the gross forms that reduce the abundance of fish, but rather waste materials that affect the quality of the product. These include such pollutants as phenols, oil, and other chemical products that cause unpleasant visual, taste, or odor characteristics. Certain reaches of many rivers are unsuitable for commercial production not because fish are any less abundant, but because the fish present have been rendered unmarketable. Commercial fishermen along the Upper Mississippi River have reported barge spills, accidental dumpings and other incidents that have reduced the marketability of their catch. While many of these effects are occasional and transitory, and often result from accidents or poor housekeeping practices by firms and municipalities, they nevertheless are serious impediments to an industry whose products are sold directly for human consumption.

2.385 Although the number of individuals in the river fisheries has fluctuated over the years, there appears to be a steady downward trend on the Mississippi since 1957. Declining prices, particularly for carp, is probably the major contributing factor to attrition from the fishery and the lack of entry of younger men. Increasing industrial development along the river has also made other jobs available with higher incomes and more security than has been found in the commercial fishery. In this regard, water quality has exerted an important influence by adding to the uncertainty of fishing by rendering the fisherman's catch unsalable on various occasions.

2.386 The large number of part-time fishermen working on the rivers and the relatively low incomes and capital value of full-time fishermen indicate that many fishermen will find it difficult to make large investments for expensive gear innovations brought about by technological changes. It is likely, too, that major changes in the fishery such as those implied by indistrial fish production will involve only a few fishermen and not necessarily those currently operating in the fishery. That is, with the relatively capital-intensive operating units necessary for volume production, few fishermen will be needed in relation to total landings and those that are may use skills not developed in the traditional river fishery.

2.387 Some antagonism has been expressed in the past by full-time commercial fishermen towards those who enter the fishery seasonally, particularly those fishing for catfish. It is believed that part-time fishermen compete with full-time operators for the larger more marketable sized fish, drive down local prices and in some cases interfere with net placement on the fishing grounds. Studies on the fisheries of the Tennessee River and Mobile Delta of Alabama have indicated that capital investment for nets and equipment is approximately the same for full-time and part-time fishermen, suggesting that full-time fishermen are relatively more efficient in their use of fishing equipment. On the other hand, for individuals who work seasonally and who have little employment alternatives during the off-season, fishing can provide a source of income during slack periods with relatively little investment in equipment. In this respect, part-time operators may be making more efficient use of their time or labor than full-time fishermen in the sense that net income for the average full-time fisherman is low in relation to the time spent fishing and to other alternative employment.

2.388 Future price increases for carp and other river species brought about by marketing advances may tend to increase the participation of part-time fishermen. To what extent their landings will influence prices and fish populations is not known.

2.389 Trapping data have been collected for the past three decades by the Upper Mississippi River Wildlife and Fish Refuge, which is managed by the Bureau of Sport Fisheries and Wildlife of the U. S. Department of the Interior. This refuge was established by Congress in 1924 and runs for 284 miles along the Upper Mississippi River from about Wabasha, Minnesota, to above Rock Island, Illinois, or from approximately lock and dam 4 to lock and dam 13. Between 1940 and 1970, an average of 748 trappers per year obtained trapping permits. Between 1940 and 1970, 25,000 beavers and over 2.25 million muskrats were trapped whose furs averaged nearly $100,000 annually. By the 1971-1972 season, the price of muskrat pelts exceeded $1.00 and the annual harvest was valued at approximately $200,000. The value of furs from the Upper Mississippi River Wildlife and Fish Refuge is expected to exceed $500,000 for 1973-1974.

FOREST MANAGEMENT

2.390 The objectives of forest management are to benefit the wildlife, recreational and economic values of the land in the best possible manner.

2.391 The floodplain forest within the confines of the Upper Mississippi River Wildlife and Fish Refuge are managed for wildlife purposes. Openings are created to produce edge effects for the benefit of wildlife. A constant supply of cavity or den trees is maintained as well as the preservation of food source trees and vegetation for various species of birds and mammals. Major river islands are exempt from cutting because of their recreational potential.

2.392 Information for the Forest Management Plan of the Winona District (pools 4, south of the Chippewa River, 5, 5A and 6) Upper Mississippi River Wildlife and Fish Refuge is summarized as follows:

Pool	Acres of Federal Forested Lands	Availability (1969) Board Feet of Merchantable Saw Timber	Chords of Pulpwood
4	3,975	22,315,000	30,000
5	3,159	17,508,000	20,504
5A	2,215	9,537,000	17,820
6	700	2,219,000	6,870

RECREATION

2.393 In addition to the industrial activity described above, the northern section of the Upper Mississippi River has provided innumerable recreation opportunities for the entire region. Even prior to Congressional authorization of the 4½-foot channel in 1878, settlers used the river extensively. The Upper Mississippi River provided the opportunity to boat, fish, hunt, and sightsee. However, the settlers' needs while carving out an existence in the early nineteenth century Minnesota wilderness meant that recreational uses of the upper river were few. Thus, boating at that time was not primarily for recreational purposes. It was essential for the settlers' existence and to move people and supplies to where they were needed. Similarly, hunting and fishing were not for sports. They provided the food needed to feed the settlers' families. Surplus fish or game were sold or traded to provide necessities required for daily living.

2.394 As the twentieth century dawned, increasing leisure time accompanying the settlers' changing standard of living led to more strictly recreational use of the Upper Mississippi River. Segregating present-day recreational uses of the study area from those existing in 1930, prior to the 9-foot channel, presents problems. It is difficult to isolate increased recreational uses of the river caused by more people in the region, changed standards of living, and increased leisure, from those caused by improved navigational and other recreational opportunities.

2.395 A significant portion of today's recreational activity on the Upper Mississippi River is due to the improved navigation opportunities for large pleasure craft, and to improved fish and game habitat resulting from higher water levels created by the locks and dams.

2.396 The potential for improved hunting and fishing has not always been realized. The natural process of sedimentation has been aggravated by impoundment and by dredging activities and has covered fish spawning grounds, slough openings onto the main channel, and wildlife feeding and breeding grounds. In addition, increased industrialization along the river has caused pollution that decimated some fishing and hunting areas and has rendered some fish inedible because of unpleasant taste as a result of pollutants.

2.397 According to a home interview survey which was conducted by the U.S. Bureau of the Census, 1960 demand for outdoor recreation in the Upper Mississippi River basin was 1,582 million activity occasions. An activity occasion is participation by an individual in any one activity during any part of a 24-hour period. Of these activity occasions, 73 percent originated from metropolitan or urban areas with over 50,000 population. The demand for water-based and water-enhanced activities was 294 million activity occasions. These activities included swimming, canoeing, sailing, other boating, waterskiing, picnicking, sightseeing, nature walks and hiking. Approximately 16½ percent of this total 1960 outdoor recreation demand originated in the study area considered in this report. Projected total recreation demands for this area are given below.

Projected outdoor recreation demand for the study area

Recreation demand Activity occasions (millions)			
1960	1980	2000	2020
262	513	859	1196

2.398 In the future, the degrees of participation in various recreational activities are expected to increase at different rates. The expected increases can be attributed primarily to the rapid population expansion

of the Minneapolis-St. Paul area. On the average, annual participation in those activities related to water is expected to increase by more than five times by the year 2020, while participation in other general activities will increase about 3.5 times.

2.399 According to a 1964 inventory by the Bureau of Outdoor Recreation, the entire upper basin included 10,935 recreation areas which encompassed 5,018,255 acres of land and 621,095 acres of water. Location and distribution of recreation areas is a problem in that most of the recreation capacity is relegated to a small segment of the inventoried acreage. For example, intensively developed lands make up only 1.5 percent of the inventoried recreation acreage for the basin but provide 72 percent of the recreation capacity. The area which includes Minneapolis and St. Paul accounts for 14 percent of the population of the Upper Mississippi River basin but has 38 percent of the inventoried recreation acreage. The study area contains about 70 percent of the inventoried acreage.

2.400 Recognized present and future outdoor recreation needs for the Upper Mississippi River basin (excluding hunting and fishing) are indicated in terms of recreation days in Exhibit 108.

2.401 Boating activity and related facilities - Much of the increased boating in the study area of the river, and virtually all of it for the deeper-draft pleasure boats, is made possible by the improved navigational opportunities provided by the system of locks and dams. Exhibit 109 illustrates the dramatic growth in pleasure boating in the study area from 1960 to 1972. The exhibit shows that the number of pleasure boats moving through each lock in the study area increased by an average of 1,500 boats during the twelve-year period.

2.402 At the present time various recreational facilities are provided in the 9-foot channel project area by Federal, State, and local governmental agencies and commercial or private interests. Facilities range widely in adequacy, completeness, and capacity and many are considered as primitive and temporary. Generally, facilities are inadequate for the volume of user demand. The following paragraphs give a general outline of overall public facilities presently in existence in the project area and the participating, owning or operating agencies or other interests. Existing facilities and the extent of development are treated in greater detail in the discussions below.

2.403 Although the Corps of Engineers has participated in joint recreational development in the project pool areas, only one site has been constructed and is managed entirely by the Corps. The Corps of Engineers' site is located in pool 3 and consists of campsites, picnicgrounds, and water and sanitary facilities. However, no access to the water has been provided. The developments in which the Corps has participated on a cost-sharing basis include 13 access sites. Of this total, nine were developed jointly with the Bureau of Sport Fisheries and Wildlife, one with the Minnesota Department of Natural Resources, and three with local governmental agencies.

2.404 In addition to the nine Corps-Bureau access sites in the refuge, the Bureau has constructed six other access sites on Corps of Engineers' lands. In addition, various access areas on Bureau-administered lands have been constructed by the Bureau in cooperation with local governments or other interests. Most of these sites consist of parking areas and launching ramps. Such facilities are generally located in areas where they benefit fishermen and hunters rather than the pleasure-boating public.

2.405 In addition to the access site developed jointly with the Corps of Engineers on Corps-administered land, the Minnesota Department of Natural Resources (Minn. DNR) developed two other access sites in the wildlife area, one of which is on Corps-administered land. In other pool areas, the Minn. DNR has developed access sites consisting of parking areas and launching ramps for the convenience of hunters and fishermen.

2.406 Numerous access sites have been constructed by the Minnesota Department of Highways for use by the general public in open, easily accessible areas. Known sites in the project area are: one on the St. Croix River at Stillwater; two on Lake Pepin; at Lake City and near Frontenac; and one at La Crescent.

2.407 Five Wisconsin State parks provide for varied activities and four have limited launching facilities which permit direct access to water in the project pools. Leases have been issued to the Wisconsin Department of Natural Resources (Wis. DNR) for development of access sites at three locations on Corps-administered land. One site is located in the pool 7 area, and two sites are located in the pool 5 area. Various other access sites have been developed by the Wis. DNR on other lands.

2.408 The Wisconsin Highway Commission has constructed two wayside parking areas on lands leased from the Corps of Engineers. Numerous turnouts or wayside parking areas, some with water access facilities, also have been developed by the Highway Commission on other lands along fringes of the pool areas.

2.409 At the present time the Iowa State Conservation Commission is developing an area at Guttenberg in the pool 10 area. The site will be on Corps-administered lands under lease agreement and will provide for water access and other activities. One small area on Conservation Commission land that provides access to Wyalusing Slough in the pool 10 area has been in operation several years. In addition to the three jointly developed sites on Corps-administered lands, local governmental agencies have developed eight other sites on project lands leased from the Corps of Engineers. Three of the sites constructed jointly by the Bureau of Sport Fisheries and Wildlife and the Corps of Engineers are operated and maintained by local governmental agencies under leases.

2.410 Of the 14 sites under lease to local interests noted above, 11 sites have parking areas and launching ramps. Various other facilities are provided by local governmental agencies on lands not owned or managed by Federal or State Governments. Sites are discussed in detail in the parts of this plan pertaining to the pool area in which they are located.

2.411 Sport fishing and hunting - Precise measures of the number of sport fishermen using each specific pool in the study area are not available. Perhaps the only comparable data for all pools are the number of sport fishermen observed annually by attendants at lock and dam sites. Attendants to each lock and dam observe the river pool areas above and below their site at 3:00 p.m. each day and record the number of sport fishermen seen; the annual data are simply a sum of these daily estimates.

2.412 The number of sport fishermen observed by attendance at each lock and dam in the study area are shown in Exhibit 110 for the years 1960 through 1970. There has been little change during the ten-year period of the number of sport fishermen observed, with seasonally determined concentrations near the tailwaters of locks and dams. Fish tend to seek water with a high concentration of dissolved oxygen and the dams tend to aerate the water. In addition, rheotactile responses and the availability of prey would tend to concentrate game fish nearer the upper ends of the pools. The bulk of the sport fishermen tabulated in Exhibit 110 are probably in the pool downstream from the lock and dam.

2.413 Sport hunting of waterfowl along the Mississippi River study area is a major activity. The Winona District of the Upper Mississippi River Wildlife and Fish Refuge, which covers pools 4, 5, 5A, and 6, for example, estimates that for the ten years from 1961 to 1970 an average of 12,035 hunters in the district bagged an average of 15,600 waterfowl annually.

SOCIOECONOMIC FACTORS POOL BY POOL

2.414 Insofar as information is available, this section describes the historical and archaeological characteristics, land use, employment, industry, transportation, commercial fishing, agriculture, and recreational activities and facilities for each of the navigation pools from the head of navigation at Minneapolis, Minnesota, to the southern-most boundary of the St. Paul District at Guttenberg, Iowa.

UPPER AND LOWER ST. ANTHONY FALLS

2.415 The land adjacent to the Upper and Lower St. Anthony Falls pools is one of the earliest areas of settlement in the Twin Cities. It has undergone continuous and intensive urban settlement for over 150 years. In the early period, the falls were a barrier to navigation but also a ready source of power for saw and grain mills and for manufacturing. Today, the area has many historical and cultural associations and

remaining sites of historic interest have been integrated into continuing economic use of the area. Structures and sites considered worthy of preservation in the area include: Ard Godfrey Cottage, Lady of Lourdes Church, Nicollet Island, the Third Avenue Bridge, and the Stone Arch Bridge. The Pillsbury "A" Mill, when built in 1881, was the largest flour mill in the world, and is still in operation today.

2.416 The land adjacent to these pools is almost completely zoned for industrial and commercial use so development of the riverbank top and slope is extensive. Only a few small areas have been set aside for recreation including the six-acre Father Hennepin Bluff Park. Only six acres of land are owned by the Federal Government in the upper and lower pools. This contrasts dramatically with pools downstream where, at the other extreme, in pool 9, the Federal Government owns nearly 19,000 acres.

2.417 The Upper and Lower St. Anthony pools share with pools 1, 2, and 3 their proximity to the Twin City metropolitan area. This area is the center of an economic trading network which includes some 50 counties located in central Minnesota and western Wisconsin. All of the state of Minnesota is included except the northwest, southwest, northeast, and southeast corners which are more closely tied economically to other centers.

2.418 The area had a population in 1966 of 2,744,705 of which about 38 percent or 1,042,988 were wage earners. Service industries employed over 250,000 individuals, followed by manufacturing, predominantly of food and associated products, which employed just over 240,000. Wholesale and retail trade which employed 211,000, was twice as large an employer as the next category, agriculture, forest and fisheries, which accounted for 106,000 of the employed. Transportation and utilities employed nearly 70,000 individuals. Construction and finance employed between 50 and 60 thousand each, while government accounted for employment of some 41,000. This latter figure has been projected to more than triple by the year 2020, and most categories are anticipated to at least double their numbers employed by that year. Only agriculture and forestry is anticipated to drop, approximately one-half by 2020.

2.419 The economic significance of the Upper and Lower St. Anthony Falls navigation pools (and pools 1, 2, and 3) may be seen as operating within the larger context of the economic activity of the area indicated above. The Upper and Lower St. Anthony pools are the origin or terminal point for a substantial amount of the commodities shipped in the St. Paul District. They are the end of a chain of navigable pools and open river stretching to the Gulf of Mexico. Unlike some pools in the District they are not a passive thoroughfare for shipping moving to other pools.

2.420 An analysis of the eight commercial docks adjacent to the pools suggests that the major commodities originating or terminating there are grain, cement and concrete aggregate, and coal. A comparative idea of barge

activity can be gained from studying the commercial lockages through the Upper St. Anthony Falls lock and the Lower St. Anthony Falls lock which are shown in Exhibit 111. From 1963 to 1972, commercial lockages through both locks showed steady and exceptional growth.

View downstream in 1890 of St. Anthony Falls. Note treelined bluffs except at terminal. Father Hennepin Bluff is on the left bank upstream from the Stone Arch Bridge.

2.421 The best available measures of pleasure boating activity in the St. Anthony pools are records kept of pleasure boats locking through the locks. These data, for the years 1960 to 1972, are shown in Exhibit 112. The total number of pleasure boats locked through increased for the lower pool from 0 in 1960 to 1,455 in 1972. Since more than one pleasure boat can be in the lock chambers at the same time, the total number of pleasure boat lockages is somewhat less.

2.422 Of the three public use sites in the upper and lower pools, two provide water access for boaters. With the exception of observation platforms at the locks and dams, the Corps of Engineers neither owns nor operates recreational facilities in these pools. The St. Anthony Falls pools are not oriented toward recreational uses, but are essentially commercial and industrial.

2.423 Exhibit 113 shows the number of sport fishermen observed in the St. Anthony pools. That this number is small may be attributed to the limited means of access to the pools, the urban industrial character of the area and the degree of water pollution.

2.424 The Corps of Engineers operates an overlook for sightseers at the Upper St. Anthony Falls lock. In addition, a few parks along the river are available for sightseeing and other recreational activities. These parks include Father Hennepin Bluffs Park, North Mississippi Riverfront Park, Marshall Terrace Park, and part of St. Anthony Parkway, as yet undeveloped.

POOL 1

2.425 History has not left its mark in pool 1 to the extent that it has in the St. Anthony pools. Such archaeological sites as may have existed between the high bluffs in the extremely narrow valley of this pool are likely to have been obliterated by commercial, residential, and industrial development over the past 150 years. Sites of historic interest which are known and have survived are located on the tops of the bluffs, well removed from the effects of water levels or man's activities in and alongside the river proper. Also of cultural significance, the University of Minnesota's "Centennial Showboat," moored at the bank below the University's main campus, depends in part for its appeal on its backdrop of river panorama.

2.426 The bluffs and limited floodplain in the upper 1.5 miles of the pool are occupied by industry and institutions, principally the Minneapolis barge terminal and three other barge docks, the University of Minnesota, and several hospitals. A massive urban renewal project is underway on the right bank near the head of pool 1, called the Cedar-Riverside project, which will result in a population of about 30,000 people in high rise apartments. This project includes the transformation of the old Minneapolis terminal into a riverside park.

Aerial view downstream of the lower reach of Pool 1. Dredge spoil piles are located on the west (right) bank at the Lake Street Bridge. The Ford Bridge in the background.

2.427 Downstream from the Washington Avenue Bridge to lock and dam No. 1, the remaining floodplain and the bluff slopes and tops in pool 1 consist of parks bordered by residences. Below the bluffs, most of the park area is undeveloped open space, including some spoil piles. The Federal Government owns 16 acres of land in the floodplain.

2.428 This steep-walled, undeveloped reach of the gorge provides open space, and relief from the highly urbanized Twin Cities area. Indeed, the view from within the gorge creates the illusion that one is part of a larger primitive setting. Numerous trails have been made by the frequent hikers and picnickers.

2.429 Pool 1 is part of the same large economic and trading area as the St. Anthony pools. However, pool 1 is not the origin of many of the commodities that move in barges along the Upper Mississippi River. More importantly it serves as a water link between important commodity terminals upstream, in the St. Anthony pools, and downstream.

2.430 An idea of barge activity through pool 1 can be gained from studying Exhibit 114 which shows commercial lockages at the locks at either end of pool 1. From 1960 to 1972 commercial lockages through lock 1 increased from 1,082 to 2,193 and those through Lower St. Anthony Falls increased from only 71 in 1960 to 2,072 in 1972.

2.431 Until recently, pool 1 had eight docks. Presently there are four docks, three of which are located at the Minneapolis terminal under Washington Avenue Bridge. This terminal is being relocated in St. Anthony Falls upper pool and the Minneapolis terminal is scheduled to be converted to a park. The only remaining commercial dock will be the University of Minnesota coal dock at mile 853.1.

2.432 Records of pleasure boats locking through Lower St. Anthony Falls and lock 1 provide the best available measure of pleasure boating activity in the pool. This data, for the years 1960 through 1972, are shown in Exhibit 115. The exhibit shows increases from about 1,300 pleasure boat lockages in 1960 to 2,800 in 1972 for lock 1, and from 0 to 1,455 for the Lower St. Anthony Falls lock. Generally, pleasure boats moving through locks in the St. Paul District increased by an average of 1,500 boats per year during the 12-year period. The increases for the lockages providing access to pool 1 are about average.

2.433 Facilities that have been developed in pool 1 to serve boaters are limited to docking facilities at the Minneapolis Rowing Club (mile 849.2), and a ramp at river mile 852.5. The only pleasure boats kept in the pool are rowing shells.

2.434 Fewer sport fishermen have been observed from either end of pool 1 than at any other lock and dam except at pool 2 (see Exhibit 116). The urban industrial nature of the pool and the high degree of water pollution probably discourages most fishing. Although sport hunting along the

Mississippi River study area is large, due to the narrowness of the pool and its location in the heart of the metropolitan area, hunting does not take place in pool 1.

2.435 There are no Federal or State parks in the area backing pool 1. Public use facilities are owned and managed by the Minneapolis Park Board and St. Paul Community Services (park system).

2.436 Perhaps the major recreational activity in pool 1 is sightseeing and picnicking. From the vicinity of the campus of the University of Minnesota to lock and dam No. 1, both banks of pool 1 are largely devoted to narrow strip parks. These parks cover the steep slopes of the bluffs and a small strip of the level tops of the bluffs. They are interlaced with pathways, benches, tables, fireplaces, etc., which encourage recreational walking and picnicking. There are a number of overlooks which open to vistas of the narrow, steepsided, wooded, river gorge and the busy river itself.

2.437 Recreational visitation in pool 1 is difficult to estimate since long strip parks border much of the lower pool. These parks are open along their entire length to use by residents in the vicinity as well as hikers and visitors arriving by car and bus, or boat.

POOL 2

2.438 Fort Snelling which dominates the confluence of the Mississippi and Minnesota Rivers was the State's first military post and, until 1849, the northwesternmost outpost in the nation. This site is not directly affected by water level or man's activities in the floodplain. Cantonment New Hope, the site of the makeshift encampment occupied by the soldiers who built Fort Snelling, and located on low ground near the east end of the present Mendota Bridge has been located by archaeological excavation, but has not been opened to the public.

2.439 Records show that two archaeological sites were inundated by the raising of the water level in pool 2. These were Schilling Site, a mound and village site on Grey Cloud Island, and the Sorg Site, a habitation site on Spring Lake. No other archaeological, historical, or contemporary sites of potential historical value are known to have been affected by establishment of pool 2 as part of the 9-foot channel navigation system.

2.440 Upstream from St. Paul Park (mile 829.0) to lock and dam No. 1, extensive residential, institutional,and commercial developments now claim the bluff top and floodplain in pool 2. Urban development along the 5.5 mile reach from lock and dam No. 1 to Lilydale is, however, partially screened by vegetation and high bluffs. Downstream from St. Paul Park (mile 829.0) to lock and dam 2 only occasional residential or industrial sites interrupt the floodplain and bluff slope woodlands.

Land use along the Mississippi River in pool 2, looking upstream toward the St. Paul Barge Terminal from the Metropolitan Sewage Plant.

2.441 Of Federal lands owned or managed in connection with construction and operation of lock and dam 2 and pool 2, only 55 acres protrude above the water surface, mostly in the form of a chain of small islands immediately upstream from the lock and dam on the right side of the main channel. At the present time, these islands are zoned undeveloped recreational but they have very limited potential and are not managed for any purpose due to their size, location, and the extensive degree of pollution occurring in the surrounding water. Lake Rebecca, located on the right bank of the Mississippi River adjacent to lock and dam No. 2, is actually in pool 3, but is included here due to its location immediately below the lock. Federally-owned land at Lake Rebecca, including the lake, encompasses about 130.8 acres.

2.442 The 2,500-acre Fort Snelling Park in the vicinity of the Fort is administered by the Minnesota Department of Natural Resources. A 129-acre site is operated by the city of St. Paul as "Riverside Park" and the St. Paul Department of Parks has studied an undeveloped 410-acre site in the Crosby Lake area for recreation potential. The city of Minneapolis has developed a 171-acre Minnehaha Falls Park on the right bank of the Mississippi just below and adjacent to lock and dam No. 1

2.443 Pool 2, like the upstream pools and pool 3, is part of the larger economic and trading area described under the St. Anthony Falls pools. The largest communities on pool 2 are Cottage Grove, St. Paul Park, Inver Grove, Newport, South St. Paul, St. Paul and Minneapolis, Minn. These river communities have flourished in the past partly because of commercial benefits derived from use of the rivers. Although located on pool 3, Hastings affects and is affected by activities in pool 2.

2.444 Waterborne commerce - Based upon the tonnages received and shipped, and the numbers of commercial docks and terminals, it can be estimated that 35 to 40 percent of the commercial freight activity in the St. Paul District occurs in pool 2. This excludes shipment through the pool to and from points on the Minnesota River and pools above pool 2. In addition to the city of St. Paul itself, the industrial complex at Pine Bend is a substantial bulk commodity transit point.

2.445 Data for the year 1971 are illustrative of the kinds of commodities being shipped and received at the facilities in pool 2. The largest major commodities received were:

Sand, gravel, crushed rock	1.2 million tons
Gasoline	0.9 million tons
Distilled fuel oil	0.2 million tons
Coal	0.5 million tons

Major shipments were:

Corn	0.4 million tons
Wheat	0.4 million tons
Soybeans	0.1 million tons
Coke	0.1 million tons

Total receipts for pool 2 for 1971 were 3.5 million tons and total shipments were 1.3 million tons. The following tabulation is indicative of the origins and destinations of some major commodities to and from pool 2.

Commodity	Origin	Destination
Selected grains	Minneapolis-St. Paul	New Orleans
Coal	Kaskaskia-St. Louis	Minneapolis-St. Paul
Petroleum and petroleum products	Intracoastal-New Orleans	Minneapolis-St. Paul
Sand and gravel	St. Paul	Minneapolis
Industrial chemicals and sulphur	New Orleans	Minneapolis-St. Paul
Agricultural chemicals	New Orleans	Minneapolis-St. Paul

2.446 Although the total tonnages originating and terminating in pool 2 have shown a decline as a percentage of total tonnage in the entire St. Paul District, substantial growth for the pool and the District as a whole is predicted.

2.447 A further idea of barge activity in pool 2 can be gained from studying commercial lockages through lock 2 and lock 1, which are shown in Exhibit 117. From 1960 to 1972 commercial lockages through lock 2 increased from 1,302 to 1,929, while those through lock 1 increased from 1,082 to 2,195.

2.448 The importance of pool 2 to the commercial navigation system, and the industries it serves in the Twin Cities, is further reflected in the number of barge terminals. Of the 55 barge terminals in the metropolitan area, 34 (or 62 percent) are located in pool 2. Half of these terminals are located between St. Paul Park and Lilydale at an average density of one terminal per half mile.

2.449 The list of firms owning, operating, or using facilities in pool 2 and of firms having facilities above lock and dam No. 1 and on the Minnesota River whose traffic passes through pool 2, includes many of the major companies in the Twin Cities area (see Exhibit 118).

2.450 In addition to those firms in Exhibit 118, the following also use or maintain facilities in pool 2:

Boise Cascade Company (dock)
Land O'Lakes Company, Inc. (chemical terminal)
Chevron Asphalt Company
Industrial Molasses Corporation
Dewey-Portland Cement Company
Vel-Tex Chemical Company
Northern Warehouse Company
Morton Salt Company

2.451 <u>Commercial fishing</u> - There is little commercial fishing in pool 2. The only year, during the 1960s, for which commercial fishermen reported catches in pool 2 was in 1969. In that year, 2,000 pounds were reported.

Because pollution from the Twin Cities limits both the quantity and quality of fish caught, what commercial fishing exists is done at the lower end of pool 2 near Hastings. Fish kills associated with low levels of dissolved oxygen have been reported often in pool 2. Major problems have also been reported with fish taken from Spring Lake. Frequently poor flavor has reduced the selling price of the fish and often holding tanks are required until the fish have lost this characteristic. In any event, the importance of commercial fishing in pool 2 when compared with other economic activity in the pool, or with commercial fishing in other pools, is small.

2.452 Recreation - The best available measures of pleasure-boating activity in pool 2 are records of pleasure boats locking through locks 1 and 2, the locks at each end of the pool. These data, along with the total pleasure-boat lockages through these locks, are shown in Exhibit 119 for the years 1960 to 1972. The exhibit shows a slight increase in pleasure craft locking through lock 2, from about 5,100 in 1960 to about 5,700 in 1972, and more than doubling of pleasure craft locking through lock 1, from about 700 in 1960 to about 1,600 in 1972.

2.453 Presently, no federally-operated or maintained public-use facilities are situated adjacent to pool 2 along either the Minnesota or Mississippi Rivers. Active interests of the Bureau of Sport Fisheries and Wildlife do not extend into pool 2. The State of Minnesota has one State park in the pool 2 area, the Fort Snelling State Historical Park, located at the confluence of the Minnesota and Mississippi Rivers. Existing public-use developments and the extent of joint cooperation by participating interests are summarized in the following paragraphs.

2.454 Recreational activity of the Corps of Engineers in pool 2 at present is limited to the undeveloped 55 acres located near the lock and dam at Hastings and to the 130.8-acre Lake Rebecca area adjacent to lock and dam No. 2. The facilities in the latter area consist of a small parking area, a ball diamond, and picnic tables. No toilet facilities have been constructed in the area. Because of the possible conflict with commercial navigation operating in the Mississippi River channel adjacent to the public-use area, no boat-launching facilities have been constructed on the river in the vicinity of Lake Rebecca. The quality of the water in Lake Rebecca is not suitable for body contact sports or for fishery developments. At the lock and dam, an overlook has been constructed for the public to view locking operations.

2.455 Fort Snelling State Historical Park is administered by the Minnesota Department of Natural Resources. The park has a picnic area, a swimming beach on an inland lake, and trails. Pike Island at the mouth of the Minnesota River is also included in the park. No recreation facilities or developments are available on Pike Island. The 2,500-acre park is unique because three counties, Dakota, Hennepin, and Ramsey, meet at this point.

2.456 Local governments and other public interests have provided limited access along the Mississippi River in pool 2. The city of Hastings formerly leased the 130.8 acres of Federal land in the Lake Rebecca area for recreational development and use. Due to lack of financial capability, local interests requested development of the area by the Corps of Engineers.

2.457 The city of St. Paul operates and manages two access points to the river, the Harriet Island ramp and small-boat harbor and Riverside Park. A two-lane boat-launching ramp and adjacent park facilities are available on Harriet Island. The Riverside Park area includes the Hidden Falls access and Hiawatha Park. This 129-acre park has limited picnic facilities and a paved public access road. The St. Paul Department of Parks and Recreation has studied the 410-acre Crosby Lake area, but the area is primarily low, floodplain marshland and is currently undeveloped.

2.458 The city of Minneapolis owns, manages, and has developed 171-acre Minnehaha Falls Park on the right bank of the Mississippi River just below and adjacent to lock and dam No. 1. The park has facilities for picnicking, trails along Minnehaha Creek down to its confluence with the Mississippi River, and paved access roads.

2.459 The village of Lilydale has developed a two-lane, gravel-surfaced boat-launching ramp along the Mississippi River with parking space available for 10 cars. Another access point is located near Nininger, Minnesota, on the Mississippi River north of Hastings. Minimal parking is available, but the access point has no other facilities. Nininger, incidentally, is the site of the historic Ignatius Donnelly home and is identified by a State historical roadside marker.

2.460 The only commercially operated access point in pool 2 is the St. Paul Yacht Club. One blacktop boat-launching lane is available and the public is permitted to use the ramp for a fee. A large number of parking spaces are available as the ramp is adjacent to a city parking lot. Pool 2 lacks marinas, boat sales and rental establishments, and related services, due to the surrounding land usage, the poor water quality, and the heavy commercial traffic which tends to discourage boater use.

2.461 For the reasons cited earlier in the discussion of commercial fishing, sport fishing in pool 2 declined appreciably in the dozen years prior to 1972. As at other pools, attendants at each lock and dam make observations at 3:00 p.m. each day throughout the year of the number of sport fishermen observed from their work location. Annual data for the most recent years for which these records are available appear in Exhibit 120 which shows a marked decline in sport fishermen observed from lock and dam No. 2 since 1963. Most sport fishermen observed from lock and dam No. 2 are in pool 3. Fishermen in pool 2, as seen from lock and dam No. 1, were stable at about 1,100 to 1,200 annually in the mid-1960s. However, in 1969 this number jumped to over 1,400 and then fell to about

600 in 1970. No explanation is available for this wide variation. In pool 2, these data appear to be an especially good index to sport fishing activity. To avoid the more polluted middle area of the pool below the sewage disposal plant at Pig's Eye Island, most of the fishing occurs at the upstream end near lock and dam No. 1, or at the downstream end near lock and dam No. 2.

2.462 Sport hunting of waterfowl along other parts of the Mississippi River study area is large. However, local ordinances limit use of hunting in the urban areas of pool 2. Some trapping activity occurs around the Grey Cloud Island area.

2.463 There has never been a systematic and continuous effort to determine the actual number of visitors throughout the river valley of the pool 2 area. Exhibit 121 presents the only visitor data available and is based upon spot-checks and sample counts made in 1963 by the Corps of Engineers.

2.464 Total annual visitation for recreation in pool 2 in 1963 was the third lowest of the twelve pools in the St. Paul District. This low rate of visitation was probably affected by water pollution, the relatively small and poorly marked public access points, and the occupation of the riverbank by floodwalls and levees, industry, and barge terminals.

2.465 Because the densely populated Twin Cities metropolitan area is located along the upper reach of the pool, the 1963 data seems conservative. Observations made while conducting field studies in 1973 suggest that due to the apparent improvement in water quality and the establishment of Fort Snelling State Park, the number of people now visiting pool 2 may be substantially greater than in 1963.

THE MINNESOTA RIVER

2.466 Several sites of cultural interest exist along the Minnesota River. Along the lower bluffs near Shakopee there are, for example, the Shakopee Historic District, the location of Chief Shakopee's village from the 1820s to 1852, as well as a concentration of prehistoric Indian mounds and a grist mill. Mendota is the oldest permanent white settlement in Minnesota. The historic buildings of Mendota are located on the bluffs and have not been affected by the 9-foot channel project.

2.467 Extensive residential, institutional, and commercial developments now crowd much of the blufftop upstream to Savage, and less extensively to Shakopee. By contrast, the floodplain upstream to Black Dog Lake is relatively undeveloped, while from Black Dog Lake to Shakopee barge terminals, industrial sites and croplands predominate in the floodplain. Five of the seven barge terminals on the Minnesota River are located between miles 13.9 and 21.8.

2.468 Waterborne transportation - In recent years, traffic on the Minnesota River has grown substantially, keeping pace with growth in the St. Paul District as a whole. The tabulation below shows this growth since 1962.

Year	Tons	Year	Tons
1962	1,923,190	1967	2,584,873
1963	2,231,671	1968	1,721,555
1964	2,339,271	1969	2,585,728
1965	2,207,908	1970	3,601,743
1966	2,816,376	1971	3,626,132

2.469 The Minnesota River is not a thoroughfare to other pools or tributaries. Traffic entering or leaving the Minnesota River has its destination or origin at the commercial docks in that river. Unlike all other pools and tributaries of the Mississippi River in the St. Paul District, Minnesota River exports exceed imports. In 1971, exports were 2,728,473 tons, mainly grains, and imports were 897,659 tons, mainly coal and minerals. Aerial photographs of terminals on the Minnesota River are shown on the following page. Exhibit 122 gives a more detailed account of the commodities shipped and received in 1971 illustrating the usage and value of products moving along the Minnesota River.

2.470 The overwhelming predominance of grains and grain products is apparent in Exhibit 122. A substantial benefit results from barge shipping of grain and its products down the Minnesota River. In Minnesota, most grain is grown to the northwest, west, and southwest of the Twin Cities, and trucks can haul directly to the grain terminals on the south side of the Minnesota River avoiding traffic congestion in the urban area.

2.471 There are seven commercial docks and terminals on the Minnesota River, including four that serve grain companies, one for Northern States Power, one for Richards Oil Company, and Port Marilyn (salt). See Exhibit 123.

2.472 Recreation - There is no specific information available on the actual number of pleasure boats using the lower reaches of the Minnesota River although observations indicate there is extensive usage. Only one facility exists on the Minnesota River to serve boaters using the area. This is a small boat marina with a ramp, located at the Cedar Avenue Bridge. There are no Corps of Engineers owned or operated access points on the lower Minnesota River. There is also a lack of commercial, State, and locally operated access points.

Aerial view downstream of large river terminal, Minnesota River mile 12.5.

Aerial view of land use at Black Dog Lake, Minnesota River mile 8.

2.473 Infrequent sport fishing takes place on the lower reach of the Minnesota River probably due to poor water quality. No specific data is available as to the number of sport fishermen who fish these waters. Similarly, no statistics are available that measure the rather extensive sport hunting for waterfowl in the Minnesota River valley.

ST. CROIX RIVER

2.474 Thirty miles downstream from the confluence of the Minnesota and Mississippi Rivers,in the upper reaches of pool 3, another majority tributary, the St. Croix River, joins the Mississippi River at Prescott, Wisconsin. There may be as many as five archaeological sites on the lower stretch of the St. Croix River but not enough is known of these sites to describe them more specifically.

2.475 In the lower 24 miles of the St. Croix River, a slackwater area known as Lake St. Croix is formed by a natural impoundment at the confluence of the St. Croix River with the Mississippi River. The upper reach of Lake St. Croix contains most of the towns and industries located on the lake. Residential, commercial,and industrial sites crowd the bluffs and the floodplains. There has been a continuing increase in the number of residential units along the potentially highly erodable steep bluffs, particularly on the Wisconsin side.

2.476 There are no federally-owned lands in the segment of the St. Croix River associated with the 9-foot channel project. The largest cities on this stretch of the St. Croix River are Stillwater, Minnesota, with a population of 10,191 and Hudson, Wisconsin, with 5,049 inhabitants. Prescott, Wisconsin, with a population of 2,331 is located at the confluence of the St. Croix and Mississippi Rivers. The proximity of the Minneapolis-St. Paul metropolitan area accounts for the extensive recreational use of the river. Several main trunk highways approach the pool from the St. Paul-Minneapolis area, and there are three highway bridge crossings in Wisconsin from Stillwater to the mouth.

2.477 Waterborne commerce - The St. Croix River is not the point of origin for many of the commodities that move in barges along the Mississippi River system. It serves almost exclusively as a terminal for coal products. In 1971, 1,193,602 tons of bituminous coal and 1,393 tons of non-metallic minerals terminated at docks on the St. Croix River. This barge activity is presently equivalent to about 120 trains per year, with an average capacity of 10,000 tons. Exhibit 124 shows the number of waterborne movements made on the St. Croix River in 1971.

2.478 The St. Croix River has three commercial docks and terminals, including one that serves Northern States Power. There is also some water-oriented business of interest. A boatyard and repair facility is located at mile 22.5 on the right bank. There are also excursion boats which carry substantial numbers of passengers during the warmer months of the year.

2.479 Although recent data is lacking, commercial fishermen are known to be active between Taylor's Falls and the mouth of the river. The catch is largely carp with an average catch between 1958 and 1965 of 399,000 pounds. Total employment in 1965 was five part-time commercial fishermen.

2.480 Recreation - Over 25 recreational sites of various kinds have been identified on the St. Croix from Stillwater, Minnesota, to Prescott, Wisconsin. Most of the boating facilities are geared to meet the requirements of the medium to large pleasure-type boats and cruisers, with a considerable share of the customers or users living in the Minneapolis-St. Paul metropolitan area. The relatively large number of recreational sites is evidence of the importance of the river as a recreational resource and of the substantial economic import of this recreational activity.

2.481 A study of recreational activity on Lake St. Croix was conducted by the Minnesota Department of Natural Resources from 1966 through 1971. The use intensity expressed in man-hours and camp nights of various recreational activities is available for 1968-69. As shown in Exhibit 125, the most popular form of recreation was fishing, followed by pleasure boating.

2.482 Lake St. Croix is a popular fishing area for Twin Cities residents. Of the 1,550 fishermen interviewed by the Minnesota Department of Natural Resources during 1968-69, about 44 percent were fishing for walleyes and saugers, 43 percent for several species of fish, and 7 percent were fishing for catfish. Fishing from boats was the most common. The discharge canal of the Northern States Power plant is a popular fishing area. The Minnesota Department of Natural Resources survey showed that of 1,550 fishermen interviewed, about 100 were from States other than Minnesota or Wisconsin.

2.483 A variety of parks along the river are available for sightseeing and other recreational activities. Spoil sites, such as on the Kinnickinnic River delta (mile 6.0) also are popular for these purposes.

POOL 3

2.484 There are a number of archaeological sites in pool 3, some of which have been affected by the activities of the Corps of Engineers. Still of archaeological significance is the Bartron Site, located in Goodhue County on the southern portion of Prairie Island in the Mississippi River bottomlands. This site is relatively undisturbed by farming and contains possible evidence of house form, village arrangement, and artifacts from the major Mississippian culture (1000 A.D. to 1700 A.D.). The site is owned by Northern States Power and has been excavated by Professor Eldon Johnson (State Archaeologist). It is known that Pierre Le Sueur spent the winter of 1696 there.

2.485 To date, only information on sites located on the Minnesota shore has been provided. Other sites include: Forty-five burial mounds on Prairie Island, of which 38 are now submerged and seven others are subject to erosion during high water; a village site on the southern tip of Prairie Island which was destroyed in the construction of lock and dam No. 3, and mounds and part of a village site which were destroyed in the construction of the Commissary Point recreational area.

2.486 One historic site may also have been affected. This is the site of the Le Sueur and Perrot French Trading Post which has been recorded as being on the edge of the water on Prairie Island. Since all attempts to locate the precise site have failed, it is possible that it is now under water.

2.487 There are no Federal or State parks along the Mississippi River segment of pool 3. A considerable portion of the estimated 3,430 acres of Corps of Engineer lands lying above water in pool 3 lies within the special use area managed by the Minnesota Department of Natural Resources as part of the Gores Pool 3 Wildlife Management Area. No Federal lands in pool 3 are assigned to the Bureau of Sport Fisheries and Wildlife or the Wisconsin Department of Natural Resources.

2.488 There is a multiplicity of diverse land-uses within a fifty-mile radius of pool 3. However, general physical characteristics of the river reach below the mouth of the St. Croix River have precluded the development of cities and towns in or immediately adjacent to the valley. The agricultural land use for the three bordering counties on pool 3; Pierce County, Wisconsin; Dakota County, Minnesota; and Goodhue County, Minnesota, is shown in Exhibit 126.

2.489 Hastings, Minnesota, with a population of 12,179 in 1970 is the largest community on the Mississippi River within pool 3. Although located on pool 4, the city of Red Wing, Minnesota, population 10,441, is influenced by activities in pool 3. An idea of the barge activity in the pool may be gained from studying the commercial lockages for lock 3 and lock 2 shown in Exhibit 127. From 1960 to 1972 commercial lockages through locks 2 and 3 increased by 48 percent. Commercial lockages through lock 3 increased from 1,303 to 1,931 from 1960 to 1972.

2.490 Pool 3 is neither the origin nor destination of large amounts of river cargo. Most tows simply pass through this section of the river enroute to other pools. An indication of the busy thoroughfare function of pool 3 is provided in Exhibit 128. A total of over 85,000 combined upbound and downbound commercial movements were made in pool 3 in 1971. Further indication of the mainly thoroughfare function of the pool is its lack of commercial dock facilities. There are only two commercial docks.

2.491 Commercial fishing - Pool 3 has a small but important commercial fishery in North and Sturgeon lakes located in the southernmost section. Compared with pool 4, however, it is not large. Exhibit 129 shows the catch for each year from 1960 through 1969.

2.492 The commercial catch fluctuates widely in this pool from year to year. This is probably an indication of the pool's sensitivity to environmental impacts but it also reflects the fluctuating market values of the fish. Economic factors and the proximity to pool 2, with its frequent high levels of pollution, influence the commercial catch in pool 3. Using the most recent compilation by the Upper Mississippi River Conservation Committee in its compendium incorporating the 12-year averages between 1953 and 1965, the following tabulation indicates the extent and composition of the commercial fishery in pools 3, 4 and 5.

Commercial Fish Catch By Species in Pools 3, 4 and 5 (lbs)

Species	Pool 3	Pool 4	Pool 5
Carp	75,803	1,492,265	90,519
Buffalo	5,088	47,142	9,134
Sheepshead	4,975	93,710	15,521
Catfish	2,013	35,173	14,667
Other *	2,071	37,758	11,633

* Bullheads, suckers, quillback, mooneyes, goldeneyes, garfish, and bowfins.

2.493 Recreation - The steady increase in private boating activities has led to construction of harbors in Hastings, Minnesota; Prescott, Wisconsin; a small-boat ramp at Sturgeon Lake; and access points at North Lake (Gores Wildlife Management Area). The larger recreational craft are stored and docked in the Hastings small-boat harbor apparently for use in Lake St. Croix and to a lesser extent Lake Pepin in pool 4.

2.494 The ease of auto transport on the expressways places the area of pool 3 within an hour's drive of the Twin Cities. However, once in the area, the lack of access to the river by well-paved roads makes the pool somewhat difficult to get to. Main highways traversing in the same general north-to-south direction have been routed inland past this reach of the river. The only main highways directly entering this pool are at Prescott, Wisconsin, and Hastings, Minnesota.

2.495 It appears easier to reach pool 3 by water. For pool 3 the best available measures of pleasure boating activity are records of pleasure boats locking through locks 2 and 3, the locks at each end of the pool. These data, along with the total pleasure-boat lockages through these two locks, are shown for the years 1960 to 1972 in Exhibit 130. The data show a sharp increase in pleasure craft locking through lock 3, from about 5,500 in 1960 to about 8,100 in 1972, and a small increase at lock 2, from about 5,100 in 1960 to 5,700 in 1972.

2.496 Recreational activity sponsored by the Corps in pool 3 is confined to three sites on Corps of Engineers' lands located in the Gores Pool 3 Wildlife Area. Sturgeon Lake, with a launching ramp and parking area, was initially developed by the Corps as a joint venture with the Minnesota Department of Natural Resources. A new launching ramp, dock, and parking area were constructed by the Corps in July-August 1964 and, subsequently, perimeter fencing was erected by the Minnesota Department of Natural Resources. The second site, Commissary Point, is operated and maintained entirely by the Corps of Engineers. Camping, picnicking, and parking facilities are provided on natural ground and a potable water well and pit toilets are furnished. The third site, an unimproved area on the upper end of Prescott Island opposite the mouth of Lake St. Croix, is accessible only by water and used by boaters in its primitive state for picnicking and camping.

2.497 Within the Mississippi River segment of pool 3, the Minnesota Department of Natural Resources has participated with the Corps of Engineers in development of the Sturgeon Lake access. The Department also has developed the North Lake access site on Corps' land in the wildlife area which it manages. The Gores-Vermillion River site has been developed by the Department on State-owned land.

2.498 Insofar as is known, local governments or other public interests along the Mississippi River in Minnesota have provided no free public access facilities except at Hastings where parking and launching facilities are available to a limited degree at the Hastings small-boat harbor. The ramp is located on city land. On the Wisconsin side of the Mississippi River, there are two public water-access sites. The site at Prescott and at Diamond Bluff are both located on municipally-owned land and are being operated and maintained by the local interests.

2.499 Of the eight public-use sites in the Mississippi River segment of pool 3 discussed above, six provide only access to the water and, in view of the nature and location, primarily benefit hunters and fishermen. One site has no association with water and one site has access via water only. Four of the eight sites are on Corps' land.

2.500 Exhibit 131 shows a significant increase for most years from 1960 through 1970 in the number of sport fishermen observed by lock and dam No. 3 personnel. Most of the fishermen observed were in pool 4. The increase is in sharp contrast with the continuing small numbers observed in pool 3 from the lock and dam No. 2 structure. Though these figures are too scant for conclusions, the indications are that pool 3 is not one of the more popular sport fishing pools in the Upper Mississippi River system. Sport fishing does not appear to have the popularity experienced in down-river pools because of water pollution in the area. However, walleye, sauger, northern pike, bass, crappie, sunfish, and catfish, are still plentiful.

2.501 Hunting is the most popular productive type of sport in the Mississippi River segment of pool 3 and the natural resources of the area provide a good supply of native game and locally nesting waterfowl. Bag checks by the Minnesota Department of Natural Resources reveal waterfowl harvests comparable with the State average. Between 1961 and 1973, spot bag checks revealed that hunter numbers ranged from 30 to 100 and the number of ducks, principally wood ducks, ranged from 0.53 to 1.66 per hunter.

POOL 4

2.502 The old town of Frontenac along the shore of Lake Pepin near mile 780 is the site of Frontenac State Park operated by the State of Minnesota. Neither this site, nor historic Fort Beauarnais, have been affected by the 9-foot channel navigation project. Some seven sites of archaeological interest are located in the pool but they cannot be definitely classified with information now available. There are no Federal parks along or near the Mississippi River in pool 4 area.

2.503 Pool 4, the longest pool in the St. Paul District, has the largest water area and the longest shoreline, but is fifth in acres of Federal lands. About 6,605 acres of federally-owned lands in pool 4 are above the normal flat pool elevation. The Bureau of Sport Fisheries and Wildlife has jurisdiction over 4,836 acres in the refuge area downstream from the Chippewa River. The Corps of Engineers has jurisdiction over 1,769 acres, of which 1,614 acres are located downstream from the Chippewa River, and about 155 acres which are located immediately downstream from lock and dam No. 3. Under a cooperative agreement with the Department of the Interior, the 1,769 acres of land above water, or a total of 2,898 acres of Corps-administered lands and water area, between lock and dam No. 4 and the Chippewa River have been made available to the Bureau of Sport Fisheries and Wildlife for conservation, maintenance, and management of wildlife resources and habitat in connection with the national migratory bird management program.

2.504 Red Wing, Lake City,and Wabasha, Minnesota, with populations of 10,441, 3,594 and 2,371, respectively, are the largest river communities located along pool 4. The town of Pepin, with a population of 740 is the largest Wisconsin community along the pool. The largest cities in the 50-mile zone of influence are Rochester, Minnesota, with a population of 53,766, and Eau Claire, Wisconsin, with 45,978 inhabitants. The total population within this zone of influence is estimated at 150,000, with 90,000 residing in Minnesota and 60,000 in Wisconsin.

2.505 Waterborne commerce - An analysis of commercial and industrial facilities adjacent to the pool suggests that the major commodities originating or terminating in the pool are grain, vegetable oils, and coal. Pool 4 contains five commercial docks and terminals, including two that serve the Central Soya Grain Company and Northern States Power.

2.506 An idea of barge activity in pool 4 can be gained from studying the commercial lockages (Exhibit 132), through lock 4 and lock 3, the locks at either end of pool 4. From 1960 to 1972, commercial lockages through lock 4 increased from 1,313 to 1,913 and those through lock 3 increased from 1,303 to 1,931.

2.507 Commercial fishing and trapping - Pool 4, along with pool 9, is one of the two major sources of commercial fish in the Upper Mississippi River. During the 1960s, these two pools ranked either first or second as the pool providing the greatest weight of commercial fish caught. The commercial catch in pool 4 during the 1960s is shown in Exhibit 133. The exhibit shows wide variations in the annual commercial fish catch, reaching a maximum of about 2,600,000 pounds in 1964, and a minimum of about 1,500,000 pounds in 1969.

2.508 Increased commercial fishing in pool 4 since the lock and dam construction is at least partially due to the beneficial impact of a larger area of fish habitat caused by raising the water level. However, in recent years dredge spoil placement and natural sedimentation below wing dams are seen to have reduced fish habitat. Some experts in river fishing believe that major year-to-year variations in commercial fish catches are less affected by the supply of fish in the river than by market demand, as reflected in prices commercial fishermen receive for their catch. For example, high meat prices in mid-1973 have caused fish prices to increase with an attendant increase in commercial fishing activity on the river.

2.509 An expansion of improved furbearer habitat became evident soon after establishment of the slackwater pools. Starting in 1939, trapping was allowed and has continued each year since. In 1962-63, the last complete breakdown by pools available from the Upper Mississippi River Wildlife Refuge office showed that in pool 4, 38 trappers pelted 7,389 muskrats for a total value return to the trappers of $5,969. Figures for the 1971-72 season show 11,117 muskrats harvested by 55 trappers. This indicates that the habitat remains good enough to produce a healthy, harvestable surplus.

2.510 Recreation - Lake Pepin, a naturally formed river lake, comprises over one-half the length of pool 4. Due to the presence of Lake Pepin, pool 4 provides some of the best boating in the entire St. Paul District and draws boaters from a wide area, including the Twin Cities. The pool is 44 miles long and has a water surface area of approximately 38,400 acres. A combination of size, location, relative water quality, facilities, and accessibility makes it the prime water-oriented recreational resource in the northern part of the Upper Mississippi River. It is one of the few pools in the St. Paul District which affords opportunities for sailboating.

2.511 The best available measures of pleasure boating activity in pool 4 are records of pleasure boats locking through locks 3 and 4 - the locks at each end of the pool. These data for the years 1960 to 1972 are shown in Exhibit 134. The exhibit shows sharp increases from about 4,300 in 1960 to about 6,500 in 1972, in pleasure craft locking through lock 4 and from about 5,500 in 1960 to 8,100 in 1972, through lock 3. The number of pleasure boats moving through locks 3 and 4, increased by a greater than average amount during this period.

2.512 A variety of facilities have been developed in pool 4 to serve pleasure boaters. These include numerous small boat harbors, marinas, and boat clubs as well as recreational sites and restaurants. Exhibit 135 shows the major public use facilities as of 1968.

2.513 Access to the waters of pool 4 from both shores is excellent. The Federal Government owns the land on which seven of these facilities are located, State governments own two and county and municipal governments twelve. One is owned by a sportsmen's club. Six of the small boat harbors were developed by the Corps of Engineers although they are owned and managed by others.

2.514 Pool 4 provides the largest, deepest, most versatile, and most popular fishery of any pool on the Mississippi River in the St. Paul District. Lake Pepin provides fishing similar to that of natural lakes. Fishing conditions in the balance of the pool represent a compromise between a lake fishery and an open-river fishery. The size of the pool, the variety of access points and the lack of an adequate survey program have precluded obtaining an accurate count of pool 4 visitation for past years.

2.515 The data available for 1963 appear in Exhibit 136. Total annual visitation to pool 4 in 1963 was estimated at about 360,000. This represents the equivalent of about 2.4 visits for each of the 150,000 people residing in the zone of influence. However, a creel census was made by the Minnesota Department of Natural Resources (unpublished data) during 1962-1963 and 1967-1968 and are summarized as follows:

	No. of Fishermen	No. of Hours Fishing	No. of Fish Caught Per Hour
1962-1963	112,769	424,153	0.80
1967-1968	169,361	575,230	0.66

2.516 The Winona District of the Upper Mississippi River Wildlife and Fish Refuge has collected public-use data on the portion of the refuge that lies in pools 4, 5, 5A, and 6. These data which appear in Exhibit 137 emphasize the importance of the river as a recreational resource for fishermen, water-sport, and camping activities - over 80 percent of the visitors use the river for these purposes.

2.517 Another source of data on sport fishing in pool 4 is available from records of attendants at each lock and dam who make daily observations at 3:00 p.m. each day throughout the year of the number of sport fishermen observed from their work locations. Annual data for the most recent years for which these records are available appear in Exhibit 138. Fishermen in pool 4 as seen from lock and dam No. 3 more than doubled from 1969 to 1970.

2.518 As the water level in pool 4 was raised by Corps' operations, habitat for residential and migratory waterfowl dramatically increased and sport hunting of waterfowl along the Mississippi River study area also increased. The Winona District of the Upper Mississippi River Wildlife and Fish Refuge (which covers pools 4, 5, 5A, and 6) estimates that for the 10 years from 1961 to 1970 an average of 12,035 hunters in the District bagged an average of 15,600 waterfowl annually.

2.519 A variety of parks along the river are available for sight-seeing and other recreational activities. In addition, to assist sight-seers, the Corps of Engineers operates overlooks at locks and dams in the study area.

POOL 5

2.520 One archaeological site is known to have been covered with water in pool 5 as a result of the establishment of the 9-foot navigation channel. This was a mound and habitation site at the mouth of the Whitewater River in Wabasha County, Minnesota. Too little information is available about a second site known to exist in pool 5 to give it a definite classification.

2.521 John Latsch State Park, developed and operated by the State of Minnesota, overlooks pool 5 from the bluff area just upstream from lock and dam No. 5. No Federal parks are located in the area bordering pool 5. Of the Federal lands owned in fee in pool 5, about 4,153 acres protrude above the normal flat pool elevation. Of this total, 2,044 acres are under the jurisdiction of the Corps of Engineers and 2,109 acres are under the jurisdiction of the Department of the Interior.

2.523 Under a cooperative agreement with the Department of the Interior, a total of 7,563 acres of Corps-administered lands and water area, have been made available to the Bureau of Sport Fisheries and Wildlife for conservation, maintenance, and management of wildlife resources and habitat in connection with the national migratory bird management program. Together with Bureau-administered lands, the combined area is being managed by the Bureau as the pool 5 portion of the Upper Mississippi River Wildlife and Fish Refuge.

2.523 Alma and Buffalo, Wisconsin, with populations of 956 and 671, respectively, are the largest communities on the pool. The village of Minneiska with a 1970 population of 80, is the largest Minnesota community bordering the pool. Communities away from the river contribute the majority of the estimated 100,000 population within 50 miles inland on both sides of the pool. An estimated 60,000 reside in Minnesota, 40,000 in Wisconsin.

2.524 Despite the sparsity of river communities, pool 5 is not isolated. Primary highways either closely parallel the shorelines for considerable distance along both sides of the pool or follow the nearby high-terraced areas within the valley in the same general north-to-south direction. Networks of secondary, county, and township roads connect with the primary roads to service the areas adjacent to the pool and to provide access from outlying areas. Railroads closely parallel the primary highways on both sides of the pool. No highway or railroad crossings from Minnesota to Wisconsin are located on pool 5. Neither airline service nor small airports are available in the immediate area.

2.525 Waterborne commerce - Pool 5's only commercial dock handles coal for an electric utility company, the Dairyland Power Co-op. More significantly, pool 5 serves as a thoroughfare for the river traffic between the region south of pool 5 and the Twin Cities. An idea of barge activity in pool 5 can be gained from studying the commercial lockages through lock 4 and lock 5, the locks at either end of pool 5, which are shown in Exhibit 139. From 1960 to 1972, commercial lockages through lock 5 increased from 1,305 to 1,950 and those through lock 4 increased from 1,313 to 1,913.

2.526 Commercial fishing and trapping - There is substantial commercial fishing in pool 5. Exhibit 140, which shows the commercial catch in pounds of fish from 1960 through 1969, also shows that the catch during the last five years of the decade averaged less than half the catch during the first five.

2.527 In 1939, following establishment of the slack water pools, trapping was allowed and has continued each year since then. Pool 5 has consistently been a good producer of pelts. For 1962-63, Upper Mississippi Wildlife Refuge records show that in pool 5, 36 trappers pelted 6,803 muskrats for a total value return of $6,390.00 Field figures for the 1971-72 season show 8,283 muskrats harvested by 34 trappers reporting. Muskrats enjoy the greatest expanse of suitable habitat in the marshes and shallow water area. Weaver Bottoms is of particular importance in terms of canvasback duck and swan concentrations during migration periods. Weaver Bottoms offers ample space and habitat to support considerable numbers of other species of waterfowl and muskrats although the quality of the area is declining.

2.528 <u>Recreation</u> - Records for the years 1960 to 1972 of pleasure boats locking through locks 4 and 5, along with the total number of lockages needed to lock these boats through are shown in Exhibit 141. The exhibit shows sharp increases in pleasure craft lockages. The number of pleasure craft locking through lock 5 increased from about 2,800 in 1960 to about 5,300 in 1972 and those through lock 4 from about 4,300 in 1960 to 6,500 in 1972.

2.529 In 1968, the Corps of Engineers inventoried two major public-use facilities on the river that serve pleasure boaters by providing water-access for on-water type activities. Of these 10 public-use sites, seven had been developed on Corps of Engineers' land, one on Bureau of Sport Fisheries and Wildlife land, one on municipal land, and one on private land. Of the seven sites on Corps of Engineers' lands, the Corps participated with the Bureau of Sport Fisheries and Wildlife in jointly constructing one site, Spring Lake Landing. Two sites on Corps' lands have been constructed and are being operated and maintained by the city of Buffalo, Wisconsin. No sites in pool 5 are being operated and maintained by the Corps of Engineers. In addition to participating with the Corps of Engineers in joint development of one site on Corps' land, the Bureau has developed three other sites on Corps' lands, and has developed one site on Bureau land. All five sites are being operated and maintained by the Bureau.

2.530 The Wisconsin Department of Natural Resources has developed two access sites on Corps of Engineers' lands and one site on land originally provided by the city of Alma, Wisconsin, but now owned by the Dairyland Power Cooperative. The Department operates and maintains these three sites. The Minnesota Department of Natural Resources has no known access facilities on pool 5. In connection with the management of wildlife resources, however, the Department has acquired lands and is developing the McCarthy Lake Wildlife Management Area in the vicinity of pool 5.

2.531 The city of Buffalo, Wisconsin, is the only local entity leasing Corps' lands in pool 5. In conjunction with the Buffalo County Sportsmen's League, the city has developed one site which provides water access within the city limits. The city of Alma provides similar facilities at one site on city-owned land within the city limits of Alma.

2.532 Commercial docking, boat rental,and related services are available at various points in the pool area. Boat and motor sales and service are available in the nearby city of Winona, Minnesota. Commercial sites generally do not provide facilities for do-it-yourself boat launching or car/trailer parking except on a limited basis, and fees are generally charged when these privileges are permitted.

2.533 Small islands of Federal land, including sand bars formed by dredge spoil disposal or natural accretion, frequently are used in their undeveloped state by boaters and fishermen for day-use activities and camping. The characteristics of the area together with their vulnerability to periodic flooding make it impractical to provide facilities. Use of the areas in their primitive state is not restricted, but such use is not encouraged because of maintenance problems.

2.534 Sport fishery survey data for two years, 1962-63 and 1967-68, are also available for pool 5. These are summarized in Exhibit 142 and show that the number of fish caught in pool 5 declined by about one-third from 1962-63 to 1967-68. This decline occurred in spite of an increase of about 30 percent in the number of fishing trips in pool 5, from about 40,000 to 52,000.

2.535 Still another source of data on sport fishing are the daily observations of lock and dam attendants. Annual data for the most recent years appear in Exhibit 143. Fishermen in pool 5, as seen from lock and dam No. 4, fluctuated by about 4,000 people from 1960 to 1970. The year 1969 showed a substantial jump to about 10,400 fishermen from the previous average of about 6,500, but in 1970 the level returned to the normal range.

2.536 It is estimated that in 1963, the year for which the most precise data are available, hunters made about 2,600 visits to pool 5. The Winona District of the Upper Mississippi River Wildlife and Fish Refuge (which covers pools 4, 5, 5A, and 6) estimates that for the 10 years from 1961 to 1970 an average of 12,035 hunters in the District bagged an average of 15,600 waterfowl annually in the 4 pools.

POOL 5A

2.537 Two archaeological sites containing mounds and located on Prairie Island (miles 731.5R and 727.5R) in Winona County, have been covered by levees constructed in that area. Information on three additional archaeological sites in pool 5A is not sufficient to clarify their current status.

2.538 Merrick State Park, operated by the State of Wisconsin, is located along the pool in the area upstream from Fountain City. No Federal parks are situated along or near the Mississippi River in the pool 5A area. Of the Federal lands owned in pool 5A, about 3,920 acres are above the normal flat pool. Of this total, 2,670 acres are under the jurisdiction of the Corps of Engineers and 1,250 acres are under the jurisdiction of the Department of the Interior. Under a cooperative agreement, 3,885 acres of Corps-administered lands and water area have

been made available to the Bureau of Sport Fisheries and Wildlife for conservation, maintenance, and management of wildlife resources and habitat in connection with the national migratory bird management program. Together with Bureau-administered lands, the combined area has been managed and established by the Bureau as the pool 5A portion of the Upper Mississippi River Wildlife and Fish Refuge. Except for one area, established and posted as a wildlife sanctuary, the refuge is designated as public hunting and fishing grounds during seasons established by the States of Minnesota and Wisconsin.

2.539 Fountain City (population 1,017) is the largest Wisconsin community located along pool 5A while Minnesota City (population 301) is the largest Minnesota community. The largest towns in a zone extending 50 miles inland on both sides of the pool are Spring Valley, Minnesota, with a population of 2,572, and Arcadia, Wisconsin, with a population of 2,159. Total population in the zone is estimated as 55,000 with 35,000 residing in Minnesota and 20,000 in Wisconsin.

2.540 Railroads and primary highways parallel both sides of the pool. No highway crossings exist between Minnesota and Wisconsin in pool 5A. The nearest commercial airport is Winona.

2.541 Waterborne Commerce - Pool 5A contains no commercial docks and terminals. The Corps of Engineers' boatyard is located in this pool at Fountain City, Wisconsin. This boatyard serves as the permanent base for maintenance and repair of Corps of Engineers' marine and dredging equipment used on the river and provides winter moorage for the DREDGE THOMPSON.

2.542 An idea of barge activity in pool 5A can be gained from the commercial lockages through lock 5A and lock 5. From 1960 to 1972 commercial lockages through lock 5A increased from 1,657 to 2,127.

2.543 Commercial fishing and trapping - There is substantial commercial fishing in pool 5A. In 1969 there was a catch of 239,000 pounds of commercial fish from pool 5A. Exhibit 107C illustrates the trends in the commercial fisheries catch over a 90-year span from 1894-1965 in the Mississippi River. Exhibit 144 shows the commercial catch in pounds of fish from 1960-1969 for pool 5A.

2.544 Following establishment of the slack water pools, trapping was allowed starting in 1939 and has continued each year since. Pool 5A has consistently been a good producer of pelts. For 1962-63, the Upper Mississippi Wildlife Refuge records show that in pool 5A, 41 trappers pelted 7,233 muskrats for a total value return to the trappers of $7,092.00. Field figures for the 1971-1972 season show 9,175 muskrats harvested by 61 trappers. This represents a value, at one dollar or more per pelt, of approximately $9,000.

2.545 Recreation - From 1960 to 1972 the number of pleasure boats moving through locks in the entire study area increased by an average of about 1,500 boats. The number of pleasure boats moving through locks 5 and 5A increased by significantly different amounts during this same period (Exhibit 145). While the number of pleasure boats through lock 5A increased by only about 400 (from 7,400 to 7,800), the number through lock 5 increased by about 2,500 (from 2,800 to 5,300). This difference in pleasure boats locking through 5A compared to 5 is thought to be related to the increased commercial traffic on the river. The increased tonnage requires increased lockages and with many tows of a size requiring double lockages. The wait of two to three hours to lock from pool 6 to 5A causes many pleasure boaters from the densely populated Winona area in pool 6 to confine their recreational pursuits to pool 6 and its several stretches of sandbars. This shows up in the crowded conditions on sandbars close to Winona.

2.546 Merrick State Park, river miles 735 to 736, serves as a major access to the river from Wisconsin. It is a long, narrow park extending northward from Fountain City Bay with some additional area in the river bottoms. It is a very popular camping, picnicking, swimming, boating, and fishing attraction. Backwater sloughs lead out from the park to attractive marshes and tree-lined waterways and to the main channel. Including facilities at Merrick State Park, a total of six public acess sites have been provided by Federal and non-Federal agencies and other interests for water-associated activities. Facilities have been furnished for land-based activities at some of the sites but for the most part are incidental. Development by the Corps in pool 5A has been limited to participation with the city of Winona in joint construction of one of the three sites on Corps' lands. Other participation has been in furnishing lands for a site constructed by the Bureau of Sport Fisheries and Wildlife and another site constructed by the Minnesota City Boat Club. No sites in pool 5A are operated and maintained by the Corps of Engineers. The city of Winona, in cooperation with the Wisconsin Department of Natural Resources is providing water access facilities at a location provided by an adjoining marina. The Minnesota City Boat Club, under a quasi-private lease from the Corps of Engineers, permits the public to use its boat launching facilities.

2.547 Commercial docking, boat rental, and related services are available at various points in the pool area. Boat and motor sales and service are available in the nearby city of Winona, Minnesota.

2.548 Records of sport fishermen observed daily by lock and dam attendants from their work location appear in Exhibit 146. Although 1969 was almost double the average, fishermen in pool 5A, as seen from lock and dam No. 5, averaged about 5,000 for most years between 1960 and 1970.

2.549 As the water level in pool 5A was raised by Corps' operations, habitat for resident and migratory waterbirds was initially increased. However, as with fish habitat, dredge spoil placement and natural sedimentation in recent years has reduced waterfowl habitat. Some measure of hunting activity in the pool is shown in Exhibit 147 that notes 2,200 hunting visits to pool 5A in 1963. Recreational

sites along the perimeter of pool 5A also facilitate sight-seeing picnicking, hiking, and camping.

POOL 6

2.550 The only archaeological site known to exist in pool 6 cannot be definitely classified because of inadequate information. Perrot State Park, operated by the State of Wisconsin, is located along the pool in the area upstream of Trempealeau.

2.551 Of all the pools downstream from lock and dam No. 2, pool 6 has the smallest acreage of Corps-owned lands. Of the Federal lands owned in fee in pool 6, about 1,640 acres protrude above the normal flat pool elevation of 645.5. Of this total, 295 acres are under the jurisdiction of the Corps of Engineers and 1,345 acres are under the jurisdiction of the Department of the Interior.

2.552 Under a cooperative agreement with the Department of the Interior, 325 acres of Corps-administered lands and water areas have been made available to the Bureau of Sport Fisheries and Wildlife for conservation, maintenance, and management in connection with the national migratory bird management program. Together with Bureau-administered lands, the combined area is being managed by the Bureau as the pool 6 portion of the Upper Mississippi River Wildlife and Fish Refuge. Except for one area in Wisconsin, established and posted as a wildlife sanctuary, the refuge is designated as public hunting and fishing grounds during seasons established by the Minnesota and Wisconsin conservation agencies.

2.553 Winona, with a population of 26,438, is the largest community located along pool 6. The village of Trempealeau, with a population of 743, is the largest Wisconsin community along the pool. The largest inland cities in the zone of influence extending 50 miles inland on both sides of the pool are Preston, Minnesota, with a 1,413 population and Black River Falls, Wisconsin, with a 3,273 population. Total population in the zone is estimated as 55,000 with 35,000 residing in Minnesota and 20,000 in Wisconsin.

2.554 Railroads and primary highways closely parallel both sides of the pool. Primary and secondary highways and networks of county and township roads provide lateral access through the zone of influence. One highway crossing from Minnesota to Wisconsin is at Winona. A commercial airport is also located at Winona, Minnesota.

2.555 Waterborne commerce - Pool 6 has eight commercial docks at Winona, Minnesota. As shown in Exhibit 148, two of these docks serve grain companies, three serve oil companies, two handle coal, and one terminal handles miscellaneous bulk products.

2.556 An idea of barge activity can be gained from studying the commercial lockages through lock 6 and lock 5A, which are shown in Exhibit 149. From 1960 to 1972 commercial lockages through lock 6 increased from 1,295 to 2,018 and those through lock 5A increased from 1,657 to 2,127. The growth in lockages through lock 6 is indicative of the growth of Winona as a port.

2.557 Commercial fishing and trapping - There is not a substantial volume of commercial fishing in pool 6. Exhibit 150 shows the commercial catch in pounds of fish from 1960 through 1969. The catch during the last half of the decade averages only about 60 percent of the catch obtained during the first half.

2.558 Public trapping take in pool 6 is one of the lowest of all pools in the study area due to the small amount of good furbearer habitat. However, more than 5,000 acres of privately-owned lands within the Delta Fish and Fur Farm support harvestable muskrat populations.

2.559 Recreation - Exhibit 151 shows sharp increases in pleasure craft locking through lock 6, from about 3,700 in 1960 to about 5,800 in 1972. Lockages through lock 5A have held consistently around 7,000. From this it is apparent that many pool 6 pleasure boaters go up river where pools are less active commercially and more diverse in environment. Numbers of lockages have been remarkably consistent for both locks.

2.560 Including facilities at Perrot State Park, a total of 11 public access sites have been provided by Federal and non-Federal agencies and by other interests directly oriented to water-associated activities. Facilities have been furnished for other activities at some of the sites but for the most part are incidental. Perrot State Park overlooks pool 6 from the high bluff area lying between the village of Trempealeau and Trempealeau Bay at the mouth of the Trempealeau River. The park is over 1,000 acres in size, provides general day-use recreational facilities scattered among its scenic and nature areas, and includes about 40 campsites. A boat launching area is provided at the upstream end of the park on Trempealeau Bay.

2.561 The Corps of Engineers has not participated in development of any access facilities in pool 6 but has provided land for one site, Trout Creek Landing, operated and maintained by the Bureau of Sport Fisheries and Wildlife. The Corps has constructed one small-boat harbor on Latsch Island at Winona on city-owned land. The harbor is being operated and maintained by the city. In addition to developing one site on Corps' land, the Bureau of Sport Fisheries and Wildlife has developed the Trempealeau River Landing on Bureau lands about 3 miles up the Trempealeau River in the Trempealeau National Wildlife Refuge. The Bureau is operating and maintaining both sites.

2.562 Within its corporate limits, the city of Winona has constructed and is operating and maintaining four launching areas and two small-boat harbors on municipal lands. The city also operates and maintains

the small-boat harbor constructed by the Corps of Engineers on Latsch Island. The village of Homer has constructed and is operating one access site on village-owned lands.

2.563 The commercial facilities in this pool are larger and more complete than in some other pools because of greater population concentration (the city of Winona)adjacent to the pool. Commercially furnished docking, boat rental and related services are available at various points in the pool area, and boat and motor sales and service are available at the larger facilities, generally in the larger municipalities. Free launching and parking facilities generally are not available at the commercial sites since these facilities require considerable space, and construction, operation, and maintenance costs are high.

2.564 The most precise data available on recreation visitation in pool 6 are for 1963 and appear in Exhibit 152. Total annual visitation to pool 6 in 1963 was estimated at about 110,000 which represents the equivalent of about two visits for each of the 55,000 people residing in the zone of influence.

2.565 Exhibit 153 shows variation in sport fishermen observed from lock and dam 5A and 6 since 1963. Fishermen in pool 6, as seen from lock and dam No. 5A, fluctuated by about 1,000 from 1960 to 1970. The year 1969 showed an increase to about 4,700 fishermen from the previous average of about 3,800 but in 1970 the level returned to the normal range. It should be emphasized that these data are not precise and only an index to sport fishing activity in the pool.

2.566 Some measure of hunting activity in the pool is shown in Exhibit 152 that notes 1,100 hunting visits to pool 6 in 1963. Recreational sites along the perimeter of pool 6 also facilitate sight-seeing, picnicking, hiking, and camping. In addition, there are visitors to overlooks at locks and dams.

POOL 7

2.567 Seven archaeological sites have been identified in pool 7 but, except for an area upstream from French Island which was the site of three early homesteads which have been inundated, they cannot be definitely classified because of insufficiently detailed knowledge concerning them. No developed State parks are situated along the Mississippi River in the pool 7 area.

2.568 Of the Federal lands owned in fee, it is estimated that about 7,070 acres protrude above normal flat pool level. Of the total of 14,328 acres of federally-owned land and water area in pool 7, 14,326 acres are included in the fish and wildlife refuge, of which 6,986 acres are Corps of Engineers' lands and 7,340 acres are Bureau-administered lands. No Federal land is assigned to the Minnesota or Wisconsin Departments of Natural Resources for any special use or purpose.

2.569 No large cities or towns are located on the Mississippi or Black Rivers along the pool outlines, but the 50-mile primary zone of influence is quite evenly populated. The cities of La Crosse, North La Crosse, and Onalaska, Wisconsin, and La Crescent, Minnesota, although actually located on pool 8 below lock and dam No. 7, contribute a good share of the visitation load and are partially considered in determining the populace predisposed to use the pool area. Population of the primary zone of influence for pool 7 is estimated at about 80,000 people, including 50,000 in Wisconsin and 30,000 in Minnesota.

2.570 Waterborne Commerce - Pool 7 is not the origin or terminal for any of the commodities that move in barges along the Upper Mississippi River. It serves rather as an important water link between important commodity terminals upstream and downstream. An idea of barge activity in pool 7 can be gained from the commercial lockages through lock 7 and lock 6, the locks at either end of pool 7, which are shown in Exhibit 154. From 1960 to 1972, commercial lockages through lock 7 increased from 1,324 to 2,429.

2.571 Commercial fish and trapping - There is substantial commercial fishing in pool 7, although catches showed significant year-to-year variation in the 1960s. Exhibit 155 gives the commercial catch in pounds of fish from 1960 through 1969. The wide variations in commercial catches are probably due to the presence or absence of large seine hauls and are illustrated by comparing the catch for 1962 which was three times the catch obtained in 1969.

2.572 Opening day duck harvest is approximately 3 to 4 thousand, all species combined, with an average seasonal harvest of approximately 10 to 15 thousand. Additional hunting statistics reveal that on the average, 25 deer and about 500 raccoons, squirrels, and rabbits combined, are annually harvested.

2.573 Annual trapping harvests are approximately 10,000 muskrats, 150 beaver, 2 otter and 15 mink. This represents a current annual value to the trapper of approximately 10 to 15 thousand dollars.

2.574 Recreation - Records of pleasure boats locking through locks 7 and 6, along with the total pleasure boat lockages through these two locks, are shown in Exhibit 156 for the years 1960 to 1972. The exhibit shows increases from about 6,800 in 1960 to about 9,200 in 1972 in pleasure craft locking through lock 7 and from 3,700 to 5,800 during the period for lock 6.

2.575 Nine access sites have been developed in pool 7, all on Corps-owned land managed by the Bureau of Sport Fisheries and Wildlife as part of the Upper Mississippi Fish and Wildlife Refuge. The Corps has participated in developing five of the nine sites on a cost-sharing basis, three with the Bureau, one with the city of La Crosse, and one with La Crosse

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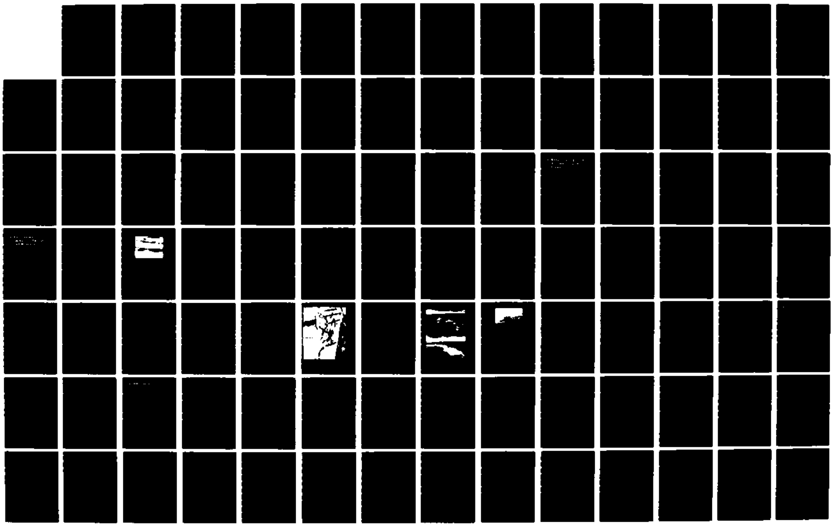

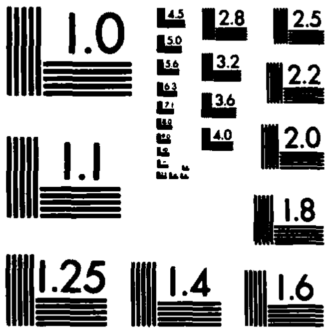

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County. No sites have been developed entirely by the Corps and no sites are being managed by the Corps. Four sites have been developed and are being managed by others. The Bureau has participated in joint development of three access sites on a cost-sharing basis with the Corps of Engineers and has constructed one other site independently on Corps' land. The Bureau operates and manages three of the four sites. The fourth site is operated and managed by La Crosse County under lease issued by the St. Paul District. All four sites provide water-access facilities consisting of parking areas and launching ramps for the benefit of fishermen and hunters.

2.576 The Minnesota Department of Natural Resources has no access facilities along pool 7. The Minnesota Highway Department has several turnout or overlook areas but no access to water is provided.

2.577 The Wisconsin Department of Natural Resources has constructed one access site in pool 7 on Corps' land in cooperation with local interests. The site is operated and maintained by the Department of Natural Resources under lease agreement with the Corps of Engineers. One access site has been constructed on a cooperative basis with local interests and two sites have been developed by the Department independently on State lands. The Wisconsin Highway Department has constructed and maintains numerous turnouts with considerable parking space along highways on fringes of the pool area. Access to water from some of the turnouts is possible but no launching ramps have been provided.

2.578 Two access sites have been developed jointly with the Corps of Engineers on a cost-sharing basis, and two sites have been developed by local governments independently. These four sites, together with one other federally-developed site, are being operated and maintained by the local governments under Corps of Engineers' leases and all on Corps' land. Three other sites have been developed by local governments on municipally-owned lands and are being operated and maintained by the municipalities. Numerous marinas, boat rental, and related services have been developed by commercial interests in the pool 7 area.

2.579 The most precise data available on recreational use of pool 7 are for 1963 and appear in Exhibit 157. Total annual visitation to pool 7 in 1963 was estimated at about 160,000 which represents the equivalent of about two visits i r each of the 80,000 people residing in the area of the pool. Annual data for the most recent years for which records are available on daily observations by lock and dam personnel of sport fishermen appear in Exhibit 158. Fishermen in pool 7, as seen from lock and dam No. 6, fluctuated by about 2,300 people during the period from 1960 to 1970. Creel censuses were made during 1962-1963 and 1967-1968. The surveys indicated that during 1962-1963, 79,930 fishermen fished about 308,740 hours and caught about 1.44 fish per fisherman hour. During the

1967-1968 survey 63,238 fishermen fished about 233,970 hours and caught about 1.10 fish per hour. A similar survey was made during 1972-1973 but the data compilations are not completed.

POOL 8

2.580 Six archaeological sites have been identified in pool 8 but information is insufficient to classify them more specifically. There are no State of Federal parks adjacent to pool 8. However, pool 8 is second only to pool 7 in the number of developed recreational sites on Corps' lands. Of the Federal lands owned in fee in pool 8, about 10,282 acres protrude above the normal flat pool elevation of 631.0. Of this total, 3,945 acres are under the jurisdiction of the Corps of Engineers and 6,337 acres are under the jurisdiction of the Department of the Interior. Under a cooperative agreement, certain Corps of Engineers-administered lands were made available to the Bureau of Sport Fisheries and Wildlife for conservation, maintenance, and management of wildlife resources and habitat in connection with the national migratory bird management program. The pool 8 portion of the refuge consists of 14,588 acres of Department of Interior lands and 9,494 acres of Corps' lands and water area for a total of 24,082 acres. Except for two areas established and posted as wildlife sanctuaries, the refuge is designated as public hunting and fishing grounds during seasons established by the States of Minnesota and Wisconsin. No Federal lands are being utilized by the States of Minnesota and Wisconsin for any special purpose in connection with wildlife and fish management.

2.581 The zone of influence is considered primarily as the area extending 50 miles on either side of the pool. The cities of La Crosse, Wisconsin, with a population of 51,153, and Onalaska, Wisconsin (population 4,909), and La Crescent, Minnesota (population 3,142), are concentrated at the upper end of the pool and along with some crossover into pool 7 comprise the bulk of potential users to pool 8. Population within the 50-mile zone is estimated at about 100,000 with 65,000 residing in Wisconsin, 20,000 in Minnesota, and, although the pool is not bounded by the State of Iowa, 15,000 Iowa residents are considered appropriately included in the zone of influence.

2.582 Waterborne commerce - Pool 8 contains seven commercial docks and terminals, including four that supply coal and petroleum to Northern States Power Company, Socony Mobil, Texas Oil Company, and La Crosse Coal Company. Another trans-ships grains for Cargill Company. An idea of barge activity in pool 8 can be gained from studying the commercial lockages through lock 8 and lock 7, which are shown in Exhibit 159. From 1960 to 1972, commercial lockages through lock 8 increased from 1,670 to 2,135 and those through lock 7 increased from 1,324 to 2,429.

2.583 Pool 8 is a major source of commercial fishing in the northern section of the Upper Mississippi River. After pools 4 and 9, pool 8 produces more fish for commercial purposes than any other. Exhibit 160 shows the annual commercial catch for most years from 1960 through 1969. Some wide fluctuations occurred during the decade, the peak catch being 1,192,000 pounds in 1962.

2.584 Recreation - The numbers of pleasure boats moving through each lock in the St. Paul District increased by an average of 1,500 boats during the 1960-1972 period. The number of pleasure boats moving through locks 7 and 8 increased by about the average for the District during this period. Seventeen water-associated public-use recreational and access sites have been developed in the pool by various Federal and non-Federal governmental agencies. Seven of these sites have been developed on Corps of Engineers' land, one on State of Wisconsin land, one on State of Minnesota land, and eight on city of La Crosse land. Three of the seven sites on Corps' land have been developed jointly by the Corps of Engineers and the Bureau of Sport Fisheries and Wildlife. Two of these sites are being managed by the Bureau and the third site is being managed by Vernon County, Wisconsin. In addition, three sites have been developed, and are being operated and maintained by local governmental entities under lease agreements. The remaining site located on Corps' land was originally developed by the Bureau and is now being operated and maintained by Houston County, Minnesota. No sites have been developed entirely by the Corps of Engineers and no sites are being operated and maintained by the Corps.

2.585 In addition to joint development with the Corps of three access sites, the Bureau of Sport Fisheries and Wildlife has developed an additional site. All four sites are located on Corps' lands within the refuge area. The Bureau is managing two of the jointly constructed sites on Goose Island and the third site is being operated and maintained by Vernon County, Wisconsin. The remaining site, originally constructed and previously operated by the Bureau, is now being operated and managed by Houston County, Minnesota.

2.586 The Minnesota Department of Natural Resources has no known access facilities in or along pool 8. Two access sites, have been developed by local interests on Minnesota Highway Department land near La Crescent, Minnesota, above and below the Interstate 90 bridge. The Minnesota Highway Department has several turnout or overlook areas but no water access is provided.

2.587 The Wisconsin Department of Natural Resources has no known access facilities in the pool 8 area. One access site on State Highway Department land at Genoa, Wisconsin, is being used in a semi-natural state and is being maintained by local interests. Several turnout or overlook areas along the highway on the pool fringes have been constructed by the Wisconsin Highway Department but no facilities have been provided for water access.

2.588 Under lease agreement with the Corps, Vernon County, Wisconsin, is operating and maintaining one site constructed by joint Corps-Bureau efforts on Corps' lands at Stoddard, Wisconsin. Under lease agreement, La Crosse County, Wisconsin, has developed and is operating and maintaining two sites on Corps' lands in Goose Island Park. The village of Stoddard has developed and is operating and managing one site on Corps' land, also under lease agreement. One site on Corps' land previously constructed and managed by the Bureau is now being operated and managed under lease agreement by Houston County, Minnesota. The city of La Crosse has provided eight access sites on city-owned and managed lands within the city limits and in the La Crosse municipal airport area on French Island located on the Black River. Two access sites have been developed and are being operated and maintained by local interests on Minnesota and Wisconsin State Highway Department lands. Numerous marinas, boat rental, and related services exist in the pool 8 area, especially in the vicinity of La Crosse.

2.589 Commercial fishing and trapping - Pool 8 is a major source of commercial fishing in the northern section of the Upper Mississippi River. The commercial catch is exceeded only by pools 4 and 9. Between 1953 and 1971 the annual commercial catch fluctuated from a low of 646,000 pounds in 1963 to a high of 1,144,000 pounds in 1962. While the total commercial catch declined from the early 1960s, the last one-half of the 1960s demonstrated a gradual increase. In 1971 over one million pounds were caught. This increase may be a reflection in the higher prices of the present markets.

2.590 Average annual harvest of furbearers was estimated by the Wisconsin Department of Natural Resources to be 75,000 muskrats, 1,000 to 1,500 beaver, 10 otter, and 50 to 75 mink for pools 7 through 10.

2.591 Fishing and hunting - The number of sport fishermen observed by attendants at lock and dam No. 7 during the years 1960 through 1970, changed little over the ten-year period. However, in 1970, over 18,000 fishermen were observed from lock and dam No. 7, most of them fishing in pool No. 8. This is the largest number observed from any lock and dam in the St. Paul District (Exhibit 161). The large number is due primarily to the large population center adjacent to lock and dam 7 and indicates the value of the walleye and sauger fishery in the pool 8 tailwaters.

2.592 It is estimated that in 1963, the year for which the most precise data are available, hunters made about 15,600 visits to pool 8. The La Crosse District of the Upper Mississippi River Wildlife and Fish Refuge estimates that for the ten years from 1961 to 1970, an average of 26,800 hunters in the District bagged an average of 49,750 waterfowl annually.

2.593 At one time there were an estimated 30,000 Indian burial mounds in Iowa. Most of them lay on prominent ridges or bluffs along the rivers and larger streams. The mounds occur in clusters or groups. A single site sometimes contains more than one hundred mounds. Mounds are in three forms: conical (round), linear (long), and effigy. The effigy mounds are large, elaborately-shaped animal forms and may measure as much as 100 feet across.

2.594 For pool 9, 1973 data provide information of the status of several Indian mound sites. R. Clark Mallam of Luther College Archaeological Research Center identified a number of Iowa effigy mounds in a report submitted to the State Historic Preservation Program. The mound sites include:

a. The Waukon Junction Mound Group, located on a high bluff overlooking the Mississippi River to the east and Paint Creek to the south. It originally consisted of one bear effigy, one bird, five conicals, and nine linears. Only three conicals remain.

b. The Keller Mound Group, located on a terrace overlooking the Mississippi River and immediately adjacent to the Lansing Interstate Public Power Plant, originally consisted of three bear effigies, 23 conicals, and four linears. There remain two bear effigies, 15 conicals, and two linears. The Luther College Archaeological Research Center has received a verbal commitment from the Interstate Public Power Corporation (IPPC) that they will not destroy the mound group. Efforts are being made to encourage the IPPC to construct a public park for the remaining mounds.

c. The Capoli Bluff Mound Group, located in a small valley facing the Mississippi River approximately 2½ miles south of Lansing consists of four bear effigies, four bird effigies, six conicals, and one linear. Except for the conicals, all are in a good state of preservation.

2.595 The Hemminway Mound Group, located on a terrace adjacent to the Mississippi River within the town limits of Lansing, originally consisted of two bears and one conical. All the mounds have been partially destroyed and the effigies are so indistinct as to eliminate the possibility of obtaining valid outlines. The group was surveyed in 1885 but the mounds were already indistinct at that time.

2.596 Effigy Mounds National Monument bordering pool 10 is the nearest large park. No Federal or State parks have been developed in the area immediately bordering pool 9.

2.597 Of the Federal lands owned in fee in pool 9, about 18,790 acres protrude above the normal flat pool elevation. Of this total, 6,620 acres are under the jurisdiction of the Corps of Engineers and 12,170 acres are under the jurisdiction of the Department of the Interior. Under a cooperative agreement with the Department of the Interior, 8,700 acres of Corps-administered lands and water area have been made available to the Bureau of Sport Fisheries and Wildlife. Together with Bureau-administered lands, the combined area is being managed by the Bureau as the pool 9 portion of the Upper Mississippi River Wildlife and Fish Refuge.

2.598 The cities of La Crosse in pool 8 and Prairie du Chien in pool 10 are the largest communities near pool 9 and probably contribute the largest part of the reciprocal cross-pool influence. The hope that the river towns would become thriving commercial centers following impoundment was not met with regard to either Lansing (population 1,218) or New Albin (population 644), the two largest river towns along pool 9, whose populations have hardly changed since 1930. Lansing has, however, been able to support a fairly substantial recreation and tourist trade. Population within the 50-mile zone is estimated at about 85,000 (1960 census) with 45,000 residing in Wisconsin and 40,000 in Iowa.

2.599 Agriculture - Bordering pool 9 are Vernon and Crawford Counties in Wisconsin, Houston County in Minnesota, and Allamakee County in Iowa. The land within the vicinity of pool 9 is largely rural. In 1969, almost 80 percent of the land in Vernon County was in farms, as was 86 percent and 77 percent of neighbor Houston and Allamakee Counties, respectively. Dairying is the major source of farm income and the principal cash crop is tobacco.

2.600 Steep slopes are characteristic of much of the farmland in Vernon and neighboring counties, especially the highly dissected "coulee country" near the Mississippi River. Such slopes limit cropland use, largely because they are difficult to cultivate with contemporary mechanized equipment. While 24.7 percent of Vernon County, 29.2 percent of Houston County, and 25.2 percent of Allamakee County were in forest land in 1969, forest products accounted for less than 1 percent of farm sales in each county.

2.601 According to the Mississippi River Regional Planning Commission (MRRPC), a third of the farms of the three counties are classified as "poverty farms" and many farmers must hold other jobs.

2.602 Accessibility - Primary highways closely parallel pool 9 for its full length on the Wisconsin side and along the upper one-half on the Iowa and Minnesota side. Secondary highways provide adequate access along the lower one-half in Iowa. One highway bridge over the main channel at Lansing with the connecting De Soto-Lansing Causeway provides for crossing between Wisconsin and Iowa. Railroads parallel

both sides of the river along the base of the high bluffs outlining the valley. Airline service is available at La Crosse, Wisconsin, and there are small airports at several smaller towns for use of private planes.

2.603 Waterborne commerce - Because pool 9 contains only two commercial docks, including one that serves Dairyland Power and one that serves Interstate Power, the pool is really a thoroughfare for river trips between the river south of pool 9 and the Twin Cities. An idea of barge activity in pool 9 can be gained from studying the commercial lockages through lock 9 and lock 8, the locks at either end of pool 9, which are shown in Exhibit 162. From 1954 to 1972 commercial lockages through lock 9 increased from 2,172 to 5,075 and those through lock 8 increased from 1,466 to 2,336.

2.604 Commercial fishing and trapping - Pool 9 shares with pool 4 the distinction of being the most important pools in the northern section of the Upper Mississippi River for commercial fishing. In every year during the 1960s except 1969, the catch in pool 4 slightly exceeded that of pool 9. The commercial catch in the 1960s is shown in Exhibit 163. There is considerable variation from year to year in the catches with a discernable trend toward larger catches in the later years.

2.605 Carp ranks first in commercial value in pool 9, with an average of 607,734 pounds per year from 1953 to 1964. Annual catfish catch during this same period was 248,741 pounds. The twelve-year average (1953 to 1964) catch for all commercial species in pool 9 was 1,333,856 pounds, greater than that for any other pool in the Upper Mississippi River except for pool 4. The average annual harvest of furbearers was estimated by the Wisconsin Department of Natural Resources to be 75,000 muskrats, 1,000 to 1,500 beaver, 10 otter and 50 to 75 mink for pools 7 through 10.

2.606 Mussel fishing - Another aspect of the commercial fishery of the Upper Mississippi River is the mussel fishery. Its commercial importance has greatly diminished since the 1920s when the market for pearl buttons disappeared. Until the 1920s, clams were fished heavily and provided the raw material for pearl buttons. With the advent of plastics the demand diminished. The Lansing Company of Lansing, Iowa, was formerly one of the major manufacturers of pearl buttons. The company is now one of the largest importers of plastic buttons and also makes zippers.

2.607 The mussel populations of the Upper Mississippi River went virtually unexploited until 1964 when interest in mussel shells was renewed. In that year the clamming industry revived slightly. Four southern companies moved operations to Prairie du Chien, Wisconsin. This move was prompted by two prime factors, the constant Japanese market for 5,000 tons of clam shells per year and the depletion of the mussel beds in the Tennessee River. In Japan, pellets of freshwater clam shell are used to stimulate the production of cultured pearls in oysters.

2.608 The four companies operating out of Prairie du Chien in 1964 were the Tennessee Shell Company with 34 boats, the George Borden Company with 10 boats, the Automatic Button Company, and the Blumenfeld Company, each with six boats. The estimated production figures for each of these companies as of 10 August 1965 were: Tennessee Shell Company - 300 tons dried weight, George Borden Company - 150 tons dried weight, and the Blumenfeld Company - 26 tons. In 1965, a ton of clams, live weight, brought $40. A ton of cooked-out shells was worth $60.

2.609 The most important clam species fished today is the Three-ridge. Other less important species include the Pig-Toe, the Warty-Back, the Maple Leaf, and the Niggerhead, which was previously of prime value. There has been some clamming recently in the Lansing-Ferryville-De Soto area of pool 9, but most clamming is done in pool 10.

2.610 Recreation - The major portion of recreation visitation to pool 9 is accommodated by 17 public-use recreational and access sites developed in the pool by various Federal and non-Federal agencies and private interests. Most of the sites have been constructed to provide water-access for on-water type activities and, in most instances, the provision of facilities for other activities is incidental.

2.611 Of the 17 public-use sites five have been developed on Corps of Engineers' lands, three on Bureau of Sport Fisheries and Wildlife lands. two on State of Wisconsin lands, six on local Government lands, and one on private land. Extent of development and participation by various contributing agencies is discussed in the following paragraphs.

2.612 Of the five sites on Corps of Engineers' lands, the Corps has participated with the Bureau of Sport Fisheries and Wildlife in jointly constructing two access sites. The two sites are being operated and maintained by the Bureau, together with a third site constructed by the Bureau alone on Corps' land. The fourth site was constructed and is being operated and maintained by Vernon County, Wisconsin. The fifth site on Corps' land was constructed and is being operated and maintained by the Wisconsin Highway Department. The Corps has constructed a small-boat harbor on town-owned land at Lansing, Iowa. The harbor is being operated and maintained by the town of Lansing which has provided public boat-launching facilities. No sites in pool 9 are being operated and maintained by the Corps of Engineers.

2.613 In addition to participating with the Corps of Engineers in joint development of two sites on Corps' lands, the Bureau has developed one site alone on Corps' land and developed one site on Bureau land. All four sites are being operated and maintained by the Bureau. Two other sites were constructed on Bureau lands by the Iowa Conservation Commission and the Wisconsin Department of Natural Resources. These departments are operating and maintaining their respective sites.

2.614 The State of Wisconsin, through its Department of Natural Resources and Highway Department, constructed and is operating and maintaining one site on Corps of Engineers' land, one site on Bureau of Sport Fisheries and Wildlife land, and two sites on State-owned land. The Wisconsin Highway Department has provided assistance to local communities in developing local access sites. The Department has also provided turnout or rest areas along Highway 35 but has not provided access to water.

2.615 The Iowa Conservation Commission constructed and is operating one access site on Bureau of Sport Fisheries and Wildlife land. The Commission has provided scenic turnout or rest areas along its highways bordering the pool but has not provided water access at these areas.

2.616 Vernon County, Wisconsin, has developed a general recreational park with water access facilities on land leased from the Corps of Engineers. Local governmental entities have provided lands, constructed, and are operating and maintaining six sites. One site was constructed and is being operated and maintained by a cooperative power company for use by the public.

2.617 Commercially furnished docking, boat rental, and related services are available at various points in the pool area, and boat and motor sales and service are available in several of the bordering towns and villages. Free launching and parking facilities generally are not available at the commercial sites since these facilities require considerable space, and construction and operation and maintenance costs are high.

2.618 For pool 9, a principal measure of pleasure boating activity is the record of pleasure boats locking through locks 8 and 9. Unfortunately, these are imprecise measures since most pleasure boating is done near Lansing, which is in the middle of the pool. The data on numbers of pleasure boats locking through locks 8 and 9, along with the total pleasure boat lockages through these two locks, are shown in Exhibit 164 for the years 1954 to 1972. The exhibit shows an increase from 4,100 in 1960 to 5,600 in 1972 in pleasure craft locking through lock 8 and from 5,186 to 5,500 during the period through lock 9.

2.619 During July 1973, time-area recreational counts were conducted on pool 9 to determine the numbers of people using the main channel and immediately associated backwaters. Additional information was obtained on numbers of powerboats of all types observed on the main channel and immediately associated backwaters. Average numbers of river craft and people actually observed per mile of river surveyed is presented in Exhibits 165 and 166. It is apparent from this data that river use by

people for all purposes is greatest in the upstream two-thirds of pool 9 (river miles 660-679). The mean number of motorized craft observed on the river per hour of day use is also greatest in the upper two-thirds of pool 9. The numbers of people and craft observed in an area relates directly to the location of recreation facilities along the river and to the location of population centers. Hunting, fishing, boating, waterskiing, and camping seem to be concentrated in the upper two-thirds of pool 9.

2.620 Fishermen in pool 9 observed daily from lock and dam No. 8 have remained at consistently high numbers from 1960 to 1970 (Exhibit 167). The data are somewhat biased because Clements Fishing Float, which can hold several hundred fishermen, is located just below dam 8 in pool 9. It is still apparent that pool 9 is one of the most heavily fished of any of the pools in the study area.

2.621 Although in the entire Upper Mississippi River, bluegills ranked first in sport catch in the surveys made in both 1956-1958 and 1962-1963, in pool 9 the 1956-1957 survey revealed, in order of importance to sport catch, that crappie species, sunfish species, sauger, freshwater drum, and walleye ranked first to fifth, respectively.

2.622 While it is generally agreed that there has been a considerable increase in both commercial and sport fishing since 1938, when lock and dam No. 9 was constructed, the potential both for increased commercial and sport fishing in pool 9 is seen to be partially offset in recent years by dredge spoil placement and by natural sedimentation which have adversely affected fish habitat, particularly in areas below wing dams.

2.623 Sport hunting of waterfowl along the Mississippi River study area is large. It is estimated that in 1963, the year for which the most precise data are available, about 6,200 visits by hunters were made to pool 9. The Lansing District of the Upper Mississippi River Wildlife and Fish Refuge, which covers pool 9, estimates that for the ten years from 1961 to 1970 an average of 5,375 hunters in pool 9 bagged an average of 9,970 waterfowl annually.

POOL 10

2.624 The pool 10 area has considerable archaeological and historic interest. The Effigy Mounds National Monument, located on the Mississippi River in Alamakee and Clayton Counties, 3 miles north of Marquette, Iowa, is a national historic monument which preserves traces of Indians living there about 1,000 years ago. It is an area of 1,467 acres divided by the Yellow River which flows into the Mississippi River. It is most significant for its effigy mounds which provide information on the burial customs of prehistoric and historic Indians. Nearly all of the mound sites located in 19th century surveys have been subsequently destroyed

by farming. In Alamakee and Clayton Counties, 132 and 44 archaeological sites respectively have been surveyed. These sites contain effigy mounds which were built along the Mississippi River bluffs and on the river flats.

2.625 Pool 10 also contains several of the larger early-day outposts and settlements. Principal existing cities on pool 10 which have developed from this early era are Prairie du Chien, Wisconsin, and Guttenberg, Iowa. On St. Feriole Island in the Mississippi River at Prairie du Chien, a number of structures which are now National Historic Landmarks and were constructed between 1808 and 1864 are owned by the State Historical Society of Wisconsin and remain as evidence of Prairie du Chien's significance as an early fur trade, steamship, and railroad center.

2.626 Wyalusing State Park is the only park in the State of Wisconsin bordering on pool 10. Direct water frontage of this park is on the Wisconsin River which joins the Mississippi River at about river mile 630.8. A boat landing exists in the backwaters of the Mississippi River which is accessible through the park.

2.627 In the State of Iowa, one continguous area consisting of three separately identified State parks abuts pool 10 in the region immediately downstream from the town of McGregor. The three are Point Anne, McGregor, and Pikes Peak State Parks. The parks presently provide facilities for numerous activities, including picnicking and camping, but these are not related to water-associated activities provided by the pool resources.

2.628 Of the Federal lands owned in fee in pool 10, about 11,095 acres protrude above the normal flat pool elevation. Of this total, 2,255 acres are under the jurisdiction of the Corps of Engineers and 8,840 acres are under the jurisdiction of the Department of the Interior. Under a cooperative agreement with the Department of the Interior, 3,719 acres of Corps-administered lands and water area have been made available to the Bureau of Sport Fisheries and Wildlife for conservation, maintenance, and management of wildlife resources and habitat in connection with the national migratory bird management program.

2.629 Area and Population - Prairie du Chien, Wisconsin, with a population of 5,540, is the largest city on the pool. Guttenberg, Iowa, with a 2,177 population, is the largest Iowa city on the pool. The largest city in the zone is Oelwein, Iowa, with a population of 7,735. Except for Lancaster, Wisconsin, with 3,756 population, all other municipalities have populations of under 3,000. Total population in the zone is estimated as 90,000, with 30,000 residing in Wisconsin and 60,000 in Iowa.

2.630 Waterborne commerce - Five commercial docks serve the needs of pool 10. Three, which are located on the Wisconsin side of the river and serve Prairie du Chien, handle coal, salt, fertilizer, steel, and grain.

In addition, two very active commercial docks serve Iowa grain shippers at McGregor (operated by the Farmers Grain Dealers Association) and at Clayton. An idea of barge activity in pool 10 can be gained from studying the commercial lockages through lock 10 and lock 9 which are shown in Exhibit 168. From 1960 to 1972, commercial lockages through lock 10 increased from 1,621 to 2,372 and those through lock 9 increased from 1,606 to 2,336.

2.631 <u>Commercial fishing and trapping</u> - Although it produces only about 30 percent of the catch provided by pool 9, pool 10 supports a substantial level of commercial fishing. There is no discernable trend in the catch data for this pool. Generally high catches in 1960 and 1961 dropped in 1962 to the lowest point for the period shown in Exhibit 169, but in 1968 and 1969 these early peaks were exceeded when annual catches of about 650,000 pounds were recorded. However, this was below the peak catch observed in the past two decades, which was the 827,000 pounds recorded for 1959. The average annual harvest of furbearers was estimated by the Wisconsin Department of Natural Resources to be 75,000 muskrats, 1,000 to 1,500 beaver, 10 otter and 50 to 75 mink for pools 7 through 10.

2.632 <u>Recreation</u> - The record of pleasure boats locking through locks 9 and 10, along with the total pleasure boat lockages through these two locks, are shown in Exhibit 170 for the years 1960 to 1972. The exhibit shows small increases in pleasure craft from about 5,700 in 1960 to about 6,200 in 1972, locking through lock 10, and from about 5,200 in 1960 to 5,500 in 1972, locking through lock 9. These lockage data probably understate the boating activity in pool 10 for several reasons. Intra-pool movement of small boats for recreation and fishing purposes are omitted, and there is unusually high movement of such boats by water and by trailer within pool 10.

2.633 Of the six access sites on Corps of Engineers' lands, the Corps has participated with the Bureau of Sport Fisheries and Wildlife in jointly constructing one site, Jay's Lake Landing. This site and two other sites constructed solely by the Bureau on Corps' lands are being operated and maintained by the Bureau. Three sites on Corps' lands in the State of Iowa have been developed by State, county, and municipal governmental interests. The Corps has constructed a small-boat harbor on city-owned land at Prairie du Chien, Wisconsin. The harbor is managed by the city which has provided boat-launching facilities adjacent to the dredged harbor basin. No recreation sites in pool 10 are being operated and maintained by the Corps of Engineers. In addition to participating with the Corps of Engineers in joint development of one site on Corps' lands, the Bureau has developed two sites along on Corps' lands and is operating and maintaining the three sites.

2.634 The State of Wisconsin, through its Department of Natural Resources and Highway Department, constructed and is operating and maintaining three sites on State-owned lands. The Department of Natural Resources is also operating and maintaining one site constructed jointly with the Bureau of

Sport Fisheries and Wildlife on Bureau lands and has provided assistance to Grant County in constructing one access site. The Highway Department has provided turnout or rest areas at points of interest where highways closely parallel the pool.

2.635 The Iowa Conservation Commission is developing, operating, and maintaining the Bussey Lake site on Corps of Engineers land within the upstream city limits of Guttenberg. The Commission also operates and maintains its boat-launching facilities at the Sny Magill Creek access on National Park Service lands in Effigy Mounds National Monument.

2.636 Clayton County, Iowa, provides general recreational facilities and a water access on the largest area of Federal land (11.1 acres) leased by the Corps of Engineers in pool 10 for recreational purposes. The city of Guttenberg, Iowa, provides a waterfront park and water access on 3.3 acres of leased Corps' land. Local government entities have provided lands, constructed, and are operating and maintaining eight sites each of which provides a water access as its main feature.

2.637 Commercially furnished docking, boat rental, and related services are available at various points in the pool area, and boat and motor sales and service are available at the larger facilities, generally in the larger municipalities.

2.638 The number of sport fishermen observed by attendants at each lock and dam providing access to pool 10 are shown in Exhibit 171 for the years 1960 and 1970. In 1970, pool 10, below lock and dam No. 9, had more than 10,000 sport fishermen observed by attendants. The size of the pool, and the variety of access points, and the lack of an adequate survey program have precluded obtaining an accurate count of pool 10 recreation visitation for past years. The most precise data available are for 1963 and appear in Exhibit 172. Total annual visitation to pool 10 in 1963 was estimated at about 150,000, which represents the equivalent of about 1.7 visits for each of the 90,000 people residing in the zone of influence. Some measure of hunting activity in the pool is shown in Exhibit 172 that notes 9,000 hunting visits to pool 10 in 1963.

SUMMARY OF MAJOR BENEFICIAL AND ADVERSE IMPACTS OF THE 9-FOOT CHANNEL PROJECT

2.639 Since the late 1930s, the 9-foot navigation project has become part of a complex setting which integrates man's socioeconomoc activities with a complex web of physical, chemical, and biological factors. It is not always possible to clearly differentiate between the effects of the project and natural events occurring on the river nor is it always possible to decide whether a given impact is beneficial or adverse.

2.640 Environmental, economic, and social impacts have resulted from construction of the 9-foot channel project. The most apparent effect of the project on natural systems has been the conversion of large areas of the

original floodplain and most of the free-flowing river to shallow, standing pools and marshes. In addition, changes have occurred in plant succession, rates of sand and silt accumulation in the floodplain, and dissolved oxygen concentrations in backwater areas. The economic impacts have accrued as a savings of energy and costs in transportation at the local, regional, and national levels. The social impacts are primarily the shaping of urban growth and recreation in such a manner as to take advantage of the aesthetic settings, navigation potentials, and recreation resources provided by the project.

IMPACTS ON TOPOGRAPHY AND GEOLOGY

2.641 The impoundments have increased the rate of accumulation of sand and silt in the floodplain. Natural sedimentation also took place before construction of the dams for the 9-foot channel project, but the closing of the dams decreased the ability of the river to transport sand and silt downstream. Sedimentation will unavoidably continue until the sediment level eventually reaches the crests of the spillways of the dams. When this will occur cannot be predicted with present knowledge and available data. There are no scientific estimates available as to how long this process will take. Some principal investigators indicated that it is taking place at an alarming rate, at the other extreme there are estimates that it could take several hundred years for some pools. It is generally accepted, however, that the navigation pools are filling with sediment and that there are attendant losses of water surface, fish and wildlife habitat, and boating areas.

IMPACTS ON SURFACE WATER AND WATER QUALITY

2.642 The construction of the locks and dams has converted approximately 243 river miles of flowing stream into standing, shallow pools and marshes. Generally, the uppermost one-third of the pools have remained somewhat similar to the pre-impoundment river.

2.643 The water quality changes associated with impoundments are based upon the accumulation of oxygen-demanding organic sediments in the slack water areas and a reduction in aeration resulting from a decrease in surface turbulence. These factors have led to decreased concentrations of oxygen, particularly in backwater sloughs which do not receive circulation from the main channel. Such isolated bodies of water also tend to have high concentrations of nitrate and phosphate because the products of biochemical and anaerobic decomposition are not flushed from the system. The production of submerged aquatic vegetation in such areas is increased. The water column in the isolated sloughs and river lakes also tends to stratify and this aggravates the oxygen deficiency in the lower layer or hypolimnion. Under these circumstances the dominant bottom-dwelling invertebrate organisms tend to shift

generally from mayflies and fingernail clams to forms which can tolerate low oxygen conditions such as chironomid (midge) larvae. When this occurs conditions can become unsuitable for fish, especially game species. The shift toward anaerobic conditions causes an accelerated accrual of organic detritus resulting in an increasingly shallower backwater environment. These conditions also result in a less biologically diverse aquatic community in the backwaters.

2.644 The patterns of flow on the river are also being altered in part by the accumulating dredge spoil material. The general tendency is for backwater sloughs and river lakes and ponds to become isolated from the main channel by a combination of natural movement of sediments, floodplain construction, and by the dredge material.

2.645 There are a number of secondary impacts which can be attributed to the 9-foot channel project. Barge traffic and heavy recreational use are implicated in such secondary impacts as turbidity caused by prop wash, bank erosion due to traffic related wave-action, increased congestion in the river, increased air pollution, increased water pollution, and a higher potential for accidental collisions. There is a potential for hazardous material spills which probably is dependent upon the rate of barge traffic. While spills of oil, anhydrous ammonia, and other hazardous material have occurred in the past, the advent of the double-skin barges, and improved methods and operating procedures could eventually reduce these spills to an insignificant level in the future.

IMPACTS ON FISH AND WILDLIFE

2.646 The increased total water surface area afforded by the impoundments has increased the space available for aquatic vegetation and animal life. As a consequence, there are undoubtedly more pounds of fish per linear mile of river, more use by waterfowl and furbearers, and more opportunities for fish and wildlife oriented recreation activity than ever before. The increase in pounds of fish has not been an entirely positive impact from the sport fishery viewpoint. A large part of the total increase in poundage of fish can be attributed to a proliferation of roughfish.

2.647 As a result of impoundment, three distinct zones can be observed in each pool, except in the Upper and Lower St. Anthony Falls pool and pool 1 which are atypical because of their narrow floodplain. The upper ends of the pools are very much as they were prior to the project except that they have more constant water levels. In the middle areas, water now backs up over islands and meadows forming large areas of marshes and comparatively shallow water. In the lower ends of the pools and immediately above each dam, an open lake-like aspect prevails.

2.648 The river probably supports a standing crop of fish in excess of 300 pounds per surface acre. Most fisheries biologists consider this to be a conservative estimate. Because the river is so productive, sport fishermen are able to fish year-round with two lines for most river fish. Catch limits are more liberal in most instances than they are in other inland waters. The great commercial catch of fish in the area is due primarily to the expansive water surface area provided by the locks and dams.

2.649 The pool areas of the river act as food production zones and the tailwaters of the dams serve as feeding zones for many species of fish. The tailwaters create a "feed lot" situation where fish congregate and are thus more easily caught. Prior to the project, a large-scale program of fish rescue was carried out each year. The rescue work was made necessary by fluctuating water levels which caused fish to be stranded in floodplain pools. Stabilization of water levels made this work unnecessary. It is probable that some of these problem areas were previously cut off by earlier channel modification such as wing dams and closing dams.

2.650 Increased water areas have probably caused populations of valuable furbearers such as muskrat and beaver to increase. In addition to being valuable monetarily, the animals provide a distinct recreational resource for trappers.

2.651 The rock rubble found in wing dams, closing dams, and shoreline protection provides excellent substrate for the growth of invertebrate animals. Because of their location in the current and because the water which flows over them is nutrient-rich and well-oxygenated, the wing dams are extremely rich in species and total numbers of invertebrates. The wing dams effectively increase the total area of river bottom for invertebrate production. They create artificial riffle areas which are the most effective areas in any stream for the production of fish food. The wing dams, closing dams, and riprap have created habitat which is necessary to some species of fish, especially the smallmouth bass and walleye. Wing dams also provide areas where fish congregate and are thus more easily harvested by fishermen.

2.652 Hexagenia mayflies and fingernail clams thrive in areas where there is a silt bottom and well-oxygenated water, and the navigation pools have provided such habitat. These insects are a nuisance at times of mass emergence when they create traffic hazards and require extensive cleanup operations. The mayflies are excellent fish food organisms, however, and on the whole they are a benefit as reflected in the abundance of fish.

2.653 There are also detrimental aspects of the increased aquatic habitat. Floodplain lakes, for example, formed by the creation of pool 2 suffer from the detrimental effects of being connected with

the polluted waters of the main stem of the river. The real cause of the adverse impact here, however, is the pollution of surface water.

IMPACTS ON RECREATION AND AESTHETICS

2.654 Dredge spoil has created many sand beaches along the main channel of the river. Because of their proximity to navigable water, the beaches are heavily utilized free of charge for swimming, picnicking, waterskiing and camping. Since these desirable recreation areas are undeveloped and unmanaged, however, they are subject to misuse and tend to accumulate litter. Boat launching facilities, picnic areas, and observation platforms have been provided for public use incidental to the navigation project. A Master Recreation Plan for the project originally prepared in 1948 was revised and updated in 1956 and 1965.

2.655 Downstream, the huge expanses of water in the impoundments have benefited the scenery of the area, in that prior to the project much less water area was visible to river residents and motorists. Impoundment has enhanced the opportunities for boating on the river. The inundated bottomlands of the lower pools now offer a labyrinth of channels and backwater lakes which are available to pleasure boaters, fishermen, and hunters.

2.656 The locks and dams in the project area are very impressive structures and most people enjoy viewing them. Many people also enjoy watching tows pass through the locks. For some, the play of spotlights and the sound of amplified radio messages are dramatic and exciting. The viewing stands at the locks are heavily patronized by visitors from most of the 50 states and many foreign countries.

2.657 The aesthetic appeal and recreation potential of the riverscape have been locally reduced due to urban development of riverbank property. The system of priorities for passage through the locks is seen as a distinct disadvantage to the recreational users of the river. At some locks two-hour waits for lock passage are not uncommon and the situation is especially bad on busy weekends and holidays.

2.658 The wing dams and closing dams which were inundated by the 9-foot channel project are navigation hazards. Wing dam locations are indicated on navigation charts so that users of the river are aware of their existence. However, on the river itself they are usually unmarked and they lie about propeller deep beneath the water, but they are also of considerable recreation value as prime angling spots.

IMPACTS ON LAND USE

2.659 The project removed farming operations from a high risk flood area. Crop production, haying, and grazing on the pre-impoundment floodplain were always subject to flooding, and access was often difficult or impossible in high water. Consequently, floodplain farms were submarginal at best, although their elimination meant loss to the tax base.

2.660 The existence of the pools has led to a need for greater cooperation between State natural resource departments, enabling the States to manage fish and wildlife resources more efficiently. The present impoundments usually extend to the railroad tracks which flank the river on either side. The tracks serve as easily recognized boundaries to the area of fishing reciprocity which lies between Minnesota and Wisconsin.

2.661 The 9-foot channel project, by dedicating almost 100 percent of the lands in the river bottoms to public ownership and control, has assured their preservation as a haven for wildlife and fishes. It also made the lands available for all times to lawful and legitimate public use, the foremost of which has been for general recreation.

2.662 The Federal ownership of bottomlands permits efficient designation of sanctuaries and open hunting areas for the welfare of migratory waterfowl populations during the hunting season. It also assures the continued use of the area by the public. Although Federal control of the bottomlands restricts, it does not completely eliminate private and industrial use of the lands. It avoids indiscriminate development, however, in that application for such uses must be made to the appropriate Federal agency, and that agency is then able to judge each request on its merits and effect upon the environment.

ECONOMIC IMPACTS

2.663 The construction of the locks and dams has established stable water levels and permitted navigation during the full shipping season. This has resulted in an increase of barge traffic which in turn has led to more economical transportation of goods, and increased development of commercial docks and industrial complexes along the river. These activities have been of substantial economic benefit and they have contributed to the employment, growth, and development of communities, particularly at the northern end of the navigation system.

2.664 The operation and maintenance of the locks and dams requires about 150 full-time and 30 part-time personnel. In addition, approximately 100 persons are employed on the maintenance dredging plants, and several personnel within the St. Paul District office are totally or partially involved with the operation and maintenance of the project.

2.665 Specific data are not available on the numbers of vessels originating in, terminating in, or passing through the study area. However, the combined incoming and outgoing movements of cargo in the St. Paul District totaled over 15 million tons in 1971.

IMPACTS UPON ARCHAEOLOGICAL AND HISTORICAL SITES

2.666 Based upon the records of the Minnesota State Archaeologist, it is known that nine sites having historical or archaeological value were either destroyed or inundated by the construction of the 9-foot channel navigation project. An additional six known sites which were not affected by raised water levels are located close to the river or to project structures. For an additional 73 sites in the vicinity of the project, insufficient information is available to determine whether the site has been affected by the 9-foot channel project.

2.667 Less information on historical and archaeological sites is available for portions of the study area within the States of Wisconsin and Iowa. Specific Wisconsin sites have been flooded on Lake Pepin, at Trempealeau, and at Wyalusing. Accurate descriptions of these sites are not available. The Wisconsin State Archaeologist has expressed concern that spoil not be placed near historical and archaeological sites located on St. Feriole Island at Prairie du Chien. Some burial mounds along the Iowa stretch of the river may have been inundated by the project.

FUTURE SETTING WITHOUT OPERATION AND MAINTENANCE ACTIVITIES

2.668 If the operation and maintenance of the 9-foot channel navigation project were discontinued, few of the beneficial impacts of the project would be retained. The Upper Mississippi River Wildlife and Fish Refuge would remain, for example, but it would be drastically changed since the natural river environment would no longer benefit from expanded water and marsh areas and from the accompanying increased fish and wildlife populations currently afforded by the pools.

2.669 If dredging operations were permanently suspended, there would no longer be a requirement for spoil disposal and the rate of sedimentation in backwater areas would be reduced. In general, because their activities would be sharply curtailed, detrimental effects on the natural environment by commercial and large pleasure craft activity would be eliminated. Towboats would no longer create turbidity, and towboat personnel would no longer have occasion to tie up and thereby damage trees along the margin of the river. Oil spills would cease. Economic savings to taxpayers would be realized as well as an increased demand for railroad services.

2.670 Detrimental impacts of discontinuing operation and maintenance activities would particularly affect the socioeconomic life of the Upper

Mississippi River. The greatest impact would be the curtailing and eventual virtual elimination of the commercial towboat activities.

2.671 A discussion of this possibility is a continuation, with some updating due to changed conditions and increased knowledge, of the so-called 9-foot channel controversy of the 1930s previously discussed in this section. In addition to the general welfare of the people who inhabit the Upper Mississippi River basin at least two major subdivisions of the transportation industry would be affected by decisions to cease or discontinue to operate and maintain the 9-foot navigation channel. These are the railroads and the waterway users.

2.672 Railroads and waterborne carriers compete with each other for the movement of bulk commodities into and out of the Upper Mississippi River region. Bulk exports are primarily grain and major bulk imports have in the past been coal, petroleum, and fertilizer. These two competing transportation modes also act as a commodity interchange service for each other. Railroads often provide long-haul (greater than 250 miles) feeder service of grain to river terminals for subsequent trans-shipment by water. Conversely, water carriers frequently deliver coal, petroleum products, and fertilizers at rail and truck heads for wider distribution to areas land locked away from navigable waterways.

2.673 Water carriers enjoy the advantage of lowest cost movement of bulk commodities for long distances. However, with the introduction of unit trains, railroads greatly increased their competitive position. Competitive rates were introduced by railroads for the most part only where alternative water transportation was available. Since introduction of unit trains, each transportation mode has, over the years, managed to maintain their substantial incremental percentage share of bulk commodity movements. This suggests that competition continues to foster the economic betterment of producers, ultimately domestic consumers, and the competitive position of U. S. grain exports in world markets.

2.674 No simplified conclusions can be reached as to overall economic merit of a waterway system in competition with railroads versus an all-rail system in the absence of waterways. It is clearly evident though that neither transportation industry alone could as satisfactorily serve the specific needs of the upper midwest region as have rail and water transportation networks together. Complicated factors need to be considered in evaluating the present transportation system. Some of these factors are:

a. The seasonality of northern waterways.
b. The limited car-loading capacity of railroads.
c. The volume advantages of barge over rail.
d. The consumption of energy by railroads and barges to move an equal volume an equal distance.
e. The acute peak of demand for transportation during harvesting season and at critical time periods of export market pressures.

f. Capacity and location of storage facilities for bulk commodities currently in place.

2.675 Examples of the introduction of new problems since the 1930s controversy have been the recent increased emphasis on the effective use of energy, environmental protection, pollution control, and social well-being.

BARGE TRANSPORTATION AND ENERGY USE

2.676 Effective energy use is particularly important in light of the present and probably continuing energy crisis. It also affects air pollution which relates directly to transportation energy consumption.

2.677 At present, transportation uses about 25 percent of the total U. S. energy budget for motive power alone. This use has been increasing at an average annual rate of about 4 percent.

2.678 In comparing the efficiency of energy use between various transportation modes, the term "energy intensiveness" is commonly used. Energy intensiveness is defined as the amount of energy (in BTUs) needed to deliver 1 ton-mile of freight. The three following studies are representative of early findings in the area of vessel fuel efficiency. The following table taken from a 1973 report by the Rand Corporation of Santa Monica, California, compares the energy intensiveness of various modes of transportation.

Freight Mode	Energy Intensiveness* (BTUs/ton-mile)	Ratios of E.I.
Waterways	500	1
Rail	750	1.5
Pipeline	1,850	3.7
Truck	2,400	4.8
Air cargo	63,000	126.

* August 1973 revision (by Dr. W. E. Mooz) indicated that 512 and 658 BTUs/ton-mile may be more correct for waterways and rail, respectively.

2.679 Another study published in "Railway Age," December 10, 1973, page 34, determined that to move a ton of freight one mile by rail, motor carrier, and water would involve the following BTU requirements:

	BTUs per net ton-mile
Rail	536-791
Barge	540-680
Motor	2,518-2,800

2.680 More recently, a study by Anthony V. Sebalel at the Center for Advanced Computation, University of Illinois produced the comparison below.

DIRECT ENERGY INTENSITIES IN BTUs/TON-MILE	
Rail	639-711*
Barge	785

*exact value depends on the amount of car switching done

2.681 The first study presents motive energy as being used more efficiently in water transportation. The third study, while only studying two forms of transportation energy intensiveness, asserts that rail transportation is more energy efficient. Sufficient overlap of the rail and barge motive energy measured in the second study implies some indetermination about the relative energy efficiency of the two modes. Such disparities exist between analysis of rail and barge transportation for a number of reasons, but are due particularly to the individual nature of specific hauls for a particular geographic location. Complicating comparison of the preceeding studies is insufficient data available to calculate average barge energy intensiveness adequately. Without better barge fuel records a blanket statement on barge versus rail fuel efficiency would be premature. Studies to date appear to have determined that whatever the differences are, these differences, if generalized, are limited. At the present time, sufficient information has not been generated which in time of energy shortage warrants a government policy decision favoring either competitive mode based solely on energy efficiency. Barge and rail shipping, however, do show marked energy savings over pipe, truck, and air transport. Under conditions of restricted petroleum energy availability, increased use of barging on the Upper Mississippi River and its tributaries remains desirable. The increased importance of shipments of grain out of the St. Paul District and increased imports of coal and petroleum products into the region will influence further barge movement. Exports of grain to other countries and shipments to other parts of the U.S. are expected to increase. Energy demands in the upper midwest are also expected to rise. In addition, freight which is now only marginally involved in barging may shift from other forms of transportation to the less energy-intensive forms. This shift may also be expected to change existing concepts of the kinds of freight suitable for barging with consequent impact on storage facilities. In many cases, economic trade-offs may exist between the mode of transportation and the size of inventories considered to be suitable. If the costs of energy rise sufficiently, increased capital necessitated by use of the slower-moving barge transportation and increased capital tied up in inventory and storage may be justified. If this occurs, other kinds of cargoes presently shipped by truck or pipeline may be diverted to barge or rail.

BARGE TRANSPORTATION AND AIR POLLUTION

2.682 Diesel engines are the most common power plants used by both tugboats and railroads. A large percentage of over-the-highway trucks use diesel engines as well. The diesel engine is slightly more efficient than the gasoline engine because of its higher compression ratio. Thus, less energy is used to move one ton of freight over one mile by diesel than by gasoline engines. Among users of diesel engines, barging probably is more efficient than either rail or truck.

2.683 The amount of air pollution caused by either diesel fuel or gasoline varies substantially only in the type of air pollution. The following table illustrates these pollution effects (U.S.P.H.S., 1968):

Type of Emission	Pounds per 1000 gallons diesel fuel	Pounds per 1000 gallons gasoline
Aldehydes (HCHO)	10	4
Carbon Monoxide (CO)	60	2300
Hydrocarbons	136	200
Oxides of Nitrogen	222	113
Oxides of Sulfur	40	9
Organic Acids (acetic)	31	4
Particulates	110	12

2.684 Based upon the energy intensiveness ratios shown earlier, a diesel truck will produce 4.8 times as much air pollution per ton-mile as a tug and barges.

BARGE TRANSPORTATION AND COST SAVINGS

2.685 A further benefit which can be attributed to the maintenance of navigation on the Upper Mississippi River is in the savings in transportation costs, particularly for bulk commodities. Estimates of these cost savings have been made based upon comparisons of rates for the least-cost alternatives. One of these estimates is the savings over the other various least-cost alternatives of between 4.0 and 5.4 mills per ton-mile according to the 1970 Upper Mississippi River Comprehensive Basin Study. It is generally recognized that bulk commodities, particularly those having low value-to-weight ratios, are appropriate for barge transport. Coal, petroleum, and grain have these characteristics and are examples of commodities that originate , terminate, or move through the St. Paul District pools on river barges. Future expansion of the barging traffic is expected as this report is being written. The probable opening of strip mines in the Montana and North and South Dakota areas will undoubtedly call

for coal terminals on this portion of the Upper Mississippi River. A rail/barge terminal or two will almost be assured with the increasing feasibility of coal utilization technology. The cheap transportation of coal downstream is sure to attract interest from mass shippers, and the unit trains of coal from the west will transfer cargo along the Mississippi River as an expediency.

2.686 The role of the Upper Mississippi River as a transportation artery is demonstrated by the burden which would be placed on the rail system (as the major alternative transportation mode used to move heavy, high-bulk commodities) in the absence of barge traffic on the river. In 1972 an estimate of over 16,300,000 tons of various commodities were received and shipped from the St. Paul District. If an average railroad car capacity of about 75 tons is used, this would be the equivalent of about 218,000 railroad cars, or some 2,180 trains of 100 cars each, or approximately six trains each day of the year.

2.687 The section immediately above was prepared in part for the Corps of Engineers by the North Star Research Institute as part of their environmental assessment of the impact of the 9-foot channel project. The importance of the waterway has been confirmed in letters from numerous industries dependent on water transportation. These letters are available for perusal by the public in the St. Paul District office. A few pertinent quotes will suggest the strength of their argument in favor of continued operation and maintenance of the 9-foot channel. For example, from the Interstate Power Company with general offices in Dubuque, Iowa (December 17, 1973):

> "Interstate Power Company started barging coal in 1941 to its Dubuque Plant and has progressively increased the quantities and facilities as each new plant has been built and expanded. Our present consumption of coal being delivered via barge to these three plants amounts to approximately 900,000 tons per year and provides 76% of the energy produced on the Interstate Power Company system. With the present trend toward reduction of available petroleum fuels and natural gas, coupled with our planned expansion of coal fired facilities for 1977, we would reach 93% of our energy being produced by barge delivered coal. This will amount to 1,800,000 tons of coal each year.
>
> When you consider the problem of alternate forms of transportation, a volume of this size would require 13,000 rail car loads (70 ton cars) each year or 50 cars each working day for present requirements and for the 1977 requirements, 25,000 rail car loads per year or 95 cars each working day. With the present hopper car shortage and the extreme demand for coal cars, it is

unlikely that the added burden on manufacturing facilities could be met. They must be developed on a planned expansion rate to provide adequate motive power, trackage and funding.

The economic effect of discontinued operation and maintenance of the 9-foot channel would require installation of rail coal unloading at our three plants with capital expenditure of several million dollars. The added shipment costs over the above present barge cost for the coal presently required would require a $4,500,000 expenditure producing an extreme economic burden on our customers at a time when inflationary trends have hit the consumer from all sides."

2.688 A letter from the Twin City Barge and Towing Company in St. Paul (December 11, 1973) addresses, among other things, some of the technical problems which would be created if the 9-foot channel were not maintained.

"Vessel Design: So as to clarify a generally held misbelief that river traffic could continue in shoal waters by merely light loading barges, we include two photos of a modern river towboat. This towboat is a 4,200 h.p. vessel designed and built to handle double-locking tows on 9-foot project rivers such as the Upper Mississippi. It is of a design common to this type of river. The vast majority of the river tonnage moved in the St. Paul District is by vessels similar to this.

The fact is that these towboats are built to operate in 8 to 9 feet of water. This is their optimum draft for peak efficiency. Their propellers are designed to be immersed in water. If the vessel rides high in the water, the propellers tend to beat in the air of the stern tunnel and create a condition called "cavitation". This causes vibration and has a consequent detrimental effect on the main machinery of the vessel. The cavitation also effects the operating efficiency as the propellers cannot produce the power nor do the rudders respond as necessary to propel and guide the tow to prevent becoming a safety hazard.

Conversely, the propellers are affected by turning too close to the bottom on the river. In a narrow channel, if there is a vertical restriction of the water by shoaling, the towboat will tend to be sucked down toward the river bottom. A vessel that might tend to float over a shoal with its propellers stopped will actually be sucked toward the bottom as the propellers draw the water from under the boat. "Deadstick" navigation only works after a fashion, going downstream. In any case, it is a highly dangerous operating procedure with tows

carrying 10 to 20,000 tons of cargo. The recent accident at Lock 26 resulting in the destruction of a gate was caused by a deep draft vessel not responding in shoal water.

Only with all fuel and water removed from the hull can the Upper River towboats achieve a draft of significantly less than 8 feet. Hence, there is no acceptable navigational alternative to a 9-foot channel."

2.689 A letter from the Minneapolis Grain Exchange (December 12, 1973) first establishes the extent to which grain is shipped and will be shipped from river ports:

> "Despite a 4 to 6 week delay in the opening of river navigation this spring because of the very serious flood problems downstream, Twin Cities area river terminals managed to increase their grain shipments substantially over the 1972 record. Through Dec. 4, 1973* when the last downbound tow departed, 4491 barges had been loaded with 230,354,000 bushels of grain, an increase of more than 13%. Assuming a normal full navigation season in 1974, and with the fleet augmented by the many new barges and towboats now under construction, it is not unrealistic to forecast a further 15 to 20% increase in 1974."

2.690 The letter also predicts a probable future trend from short haul movement of grain by trucks wherever possible to rail, and a shift wherever possible for the long haul from train to barge:

> "Trucks perform effectively on the shorter hauls, such as bringing some of the corn and soybeans from Southern Minnesota, Wisconsin, and Iowa origins to the nearby river ports, but it is quite apparent that in the months and years ahead cost and energy conservation* considerations will dictate that most of the long haul grain gathering movements be shifted from truck to rail. Yet today there is a very well publicized shortage of rail equipment to handle even the present traffic which is being offered. This simply means that wherever possible, and particularly on the longer hauls, we're going to have to rely on water transportation to the maximum possible extent, not only because there are better uses for scarce rail equipment than in competing with barges during the navigation season, but because it is probable that barge transportation is the most efficient of all the modes as to both energy and labor."

* Underlining in original.

2.691 Before concluding, the letter outlines problems which would arise from only a temporary interruption of barge traffic in the spring of 1974:

> "Even a temporary interruption of barge navigation on the Upper Mississippi at any time during the coming 1974 navigation season would be nothing less than a disaster for the Upper Midwest, and the spring months will be particularly critical. Ocean vessels will have been booked into Gulf ports in anticipation of the opening barge navigation, supplies of petroleum products and coal will have been depleted during the winter, and very large shipments of fertilizer will be needed to assure bountiful 1974 crops."

2.692 A letter from the Executive Committee, Western Railroad Traffic Association to the District Engineer, St. Paul District, dated 6 May 1974 is quoted as follows:

> "railroads could easily move the number of trains required for all of the existing and prospective waterway traffic in the Upper Mississippi River Basin. I quote the following from the presentation by Mr. T. Michael Power, Manager-Special Projects, Marketing Services, Burlington Northern, Inc., during the panel discussion on "Some Alternatives to Waterway Navigation" at the 29th Annual Meeting of the Upper Mississippi River Conservation Committee, January 9-10, 1973, Leamington Hotel, Minneapolis, Minnesota:
>
>> 'But what is the freight carrying capacity of the railroads? How much freight can be moved in a day?
>>
>> A double track railroad with a safe headway of ten minutes per train, can move 144 trains one way or 288 trains both ways in 24 hours. If they were all 10,000 ton commodity trains, at this rate, in only 18 days they could move all the tonnage barges transport on the Upper Mississippi River in a year. A single track railroad with modern signaling can safely move from 48 to 72 trains per day both ways. A modern stretch of any line of any American railroad thus has a fantastic freight carrying capacity, but the capacity of the railroads in the five states you gentlemen represent is above the national average, because this region with 10.6% of the continental United States' land area has 19% of the nation's railroad track. Probably the greatest concentration of railroads in the world.

What does this trackage and carrying capacity of a railroad mean as an alternative to the inland waterways? In 1971, the Upper Mississippi barge lines moved 52 million tons of various commodities. This amounts to 14 one hundred car trains a day at 10,000 tons each. Most railroads in this area have only 6-14 trains a day over their main lines, and thus there is tremendous excess railroad capacity in the Upper Midwest. Parallel to the Mississippi River between the Twin Cities and St. Louis, for example, there are at least five separate railroad routes. Anv one of them alone could handle an extra 14 trains per day to say nothing of dividing the traffic up between all the railroads serving this area.' As to the current actual and future potential traffic carrying capacity of the American railroads, I quote the following from page 27 of the August 1971 report on "A Study of the Environmental Impact of Projected Increases in Intercity Freight Traffic" by Battelle, Columbus Laboratories:

> 'In contrast, the traffic-carrying capacity of American railroads, exclusive of terminal facilities, may be two to three times the current rate of utilization. This is based on the results of a study of British railroads. With modernization (particularly of signalling capability), use of longer(heavier) trains, and faster operation, the traffic-carrying capacity of many railroads in the United States might be increased by a factor of seven. Thus, no capacity limitation for railroads, in contrast to highways for trucks, is evident currently or in the foreseeable future."

The letter continues as follows:

> "Rail car shortages frequently develop during the periods of heavy demand for moving grain. While storage represents an alternative to shipping of grain during the peak grain harvest period, storage, of course, involves additional costs. A good answer to the periodic rail car shortages for moving grain would be the payment of an extra charge for the use of rail cars for moving grain during the grain harvest period. If more grain were put in storage, it would obviously level off the period of high demand for rail cars. There are enough rail cars; the real problem is merely better utilization. The railroads are not free to vary their rates in response to these high demand periods."

2.693 Based upon the ideas presented by railroad and waterway interests, it is apparent that some differences exist between their viewpoints and conclusions. It would appear that the argument of alternative modes of transportation versus efficiency is not yet resolved. In all probability the actual values are located somewhere between the values presented.

PROJECTS AND PROPOSALS OF OTHER AGENCIES

UPPER MISSISSIPPI RIVER WILDLIFE AND FISH REFUGE

2.694 The Refuge is comprised of over 195,000 acres and is managed by the Bureau of Sport Fisheries and Wildlife for the conservation, maintenance, and management of wildlife resources and fish within the navigation pools of the Upper Mississippi River. Over half the acreage (106,197) is made up of lands acquired by the Federal Government in connection with the 9-foot channel navigation project and has been made available by the Corps of Engineers to the Bureau. Maintenance and patrolling of refuge lands is under the jurisdiction of the Bureau of Sport Fisheries and Wildlife.

2.695 General objectives and/or policies include the following:

1. To preserve wildland character and the natural beauty of the river bottoms.

2. To provide protection for endangered species for fish, wildlife and plants.

3. To promote the production of woodducks and to assure the continuation of an environment beneficial to migratory and resident wildlife.

4. To provide hunting and sport fishing opportunities.

5. To preserve and manage as wilderness areas, woodlands, and prairie typical of the original vegetation of the valley.

6. To encourage proper land use and zoning by local government bodies to assure the presence of the varied natural resources of the river valley and to cooperate with all land users.

7. To cooperate with public land managing agencies and private interests to develop a balanced recreation area.

METROPOLITAN DEVELOPMENT GUIDE

2.696 As formulated by the Metropolitan Council, representing the 7-county area of metropolitan Minneapolis-St. Paul, various guides

have been published for resource management. The Protection Open Space Policy Plan, adopted April 26, 1973, defines open space as the natural environment, a neighborhood playground, a marsh, a lake, a farm field, or a utility easement. Furthermore, open space is considered as a vital component of the urban environment serving irreplaceable functions such as the protection of natural resources, structuring of urban development, and provision of recreational resources. The Recreation Open Space Policy Plan recognizes the necessity to correct the disparities and deficiencies of existing recreational facilities. The plan also recognizes the need to provide for an increasing population and recreation demand as a result of greater mobility, leisure time and income.

2.697 The Water Resources Policy Plan is intended to insure proper use and protection of the water resources available in the Metropolitan Area. The development will consider surface waters and groundwaters primarily as sources of supply for domestic, commercial, industrial, navigation, recreation, and fish and wildlife propagation.

2.698 The Water Resources Policy Plan recognizes that lives and property have been lost or permanently affected by flood waters. Recognized causes include the following:

1. Floodplain development.
2. Increased development and subsequent increased water runoff.
3. Excessive precipitation and inadequate drainage and storage areas.
4. Inadequate engineering design or maintenance of drainage facilities.

MEMORIAL HARDWOOD STATE FOREST

2.699 Land acquisition began in 1966 by the Minnesota Department of Natural Resources to acquire 200,000 acres of marginal farm and forest land within 8 counties in southeast Minnesota, and 5 counties bordering the Upper Mississippi River. Objectives of the project are to manage the acquired land on a multiple land use concept including forestry management, soil conservation, recreation, game management, and trout stream reclamation. At the present time 24,000 acres of land are included in the project. Funding is presently being requested from the Minnesota Legislature for approximately 1 million dollars per year for inclusion of the remaining portion.

2.700 An attempt is being made to purchase land in compartments which are defined by watershed boundaries. At present, Hay Creek in Goodhue County and Snake Creek at Kellogg in Wabasha County are considered

completed compartments. Within specific watersheds it is planned that farmlands will be leased for cultivation as long as there is no opportunity for erosion or misuse of the leased land.

2.701 Acquisition and management of the Memorial Hardwood State Forest will be a multi-disciplined attempt to properly manage large units of land. Important contributions to project planning and implementation have already been provided by the Minnesota Department of Natural Resources, the Soil Conservation Service, and the Bureau of Outdoor Recreation.

GREAT RIVER ROAD

2.702 The Great River Road originated in an act of Congress in August 1949 instructing that a survey be made to determine the possibility of developing a national parkway generally following the course of the Mississippi River. Instead, for various reasons, a plan evolved for a scenic route to be administered by the various State Highway Departments and accomplished by improving existing highways to parkway-like standards and incorporating them into a continuous route. Congress authorized an appropriation of 90 million "for construction or reconstruction of the Great River Road" in Section 148 of the Federal-Aid Highway Act of 1973.

2.703 The Great River Road is a not yet fully realized road system along the Mississippi River from its source at Lake Itasca to its mouth at the Gulf of Mexico. It is to be accomplished by improving existing highways, acquiring additional lands and scenic easements, partially controlling access, and developing recreational, historical, and natural areas. These roads will be made into a continuous route by connecting them when necessary with sections of new construction. Presently some sections of the route of the Great River Road are marked by distinctive roadside signs wherever it follows existing highways in the several states along the Upper Mississippi River.

2.704 When completed, the Great River Road will provide a good highway network connecting various recreation areas with each other and with major Federal and State highways, including the Interstate Highway System. Also, the proposed rest areas, visitor points, and picnic areas along the road would be available for the recreationist going to and from the recreation areas.

2.705 The Corps of Engineers is involved with the Great River Road when it crosses Corps' projects or when easements are desired. In addition, the Corps is committed to full cooperation with the affected States to facilitate its completion.

NATIONAL RECREATIONAL AREA

2.706 Several bills regarding the preservation of the natural resources of the Mississippi River valley have been introduced over the past several years, the most recent of which was submitted in November 1973 and was entitled "A Bill to Create an Upper Mississippi Recreation Area" (HR 11603). The purpose of this proposed legislation was:

a. To conserve and protect in their natural state certain areas of land and water in and along the Upper Mississippi River (including certain scenic bluff areas and wetlands of the river corridor) for the general benefit, education, and enjoyment of the public.

b. To develop certain of such protected areas and other areas of land and water in and along the Upper Mississippi River for recreational use by the public.

2.707 According to the bill, the boundaries of the Upper Mississippi Recreation Area are to include the Mississippi River and portions of the first tier of counties along the river in the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin and to comprise no more than 650,000 acres of land and water. According to the bill, before the Secretary of the Interior would establish the Upper Mississippi River National Recreation Area, he would draw up a master plan, submit it to the Secretary of the Army and the five affected States for review and comment, and then submit the master plan and the comments to Congress. The plan would include:

a. Programs for the preservation and enhancement of the environmental quality of the Upper Mississippi River.

b. Programs for public outdoor recreation opportunities.

c. Programs for the conservation and protection of scenic, ecological, historical, archaeological, fish and wildlife, water quality, and other values contributing to public enjoyment.

d. Programs for the utilization of natural resources which will not impair the purposes of the act.

e. Formulation of uniform and coordinated policies for implementation of the National Recreation Area master plan, with primary aim for developing outdoor recreation and conserving natural resources.

f. Establishment of standards for all developments within the National Recreation Area.

g. Establishment of standards for the operation and maintenance of the National Recreation Area.

2.708 The National Recreation Area would be administered by the Secretary of the Interior through the Bureau of Sport Fisheries and Wildlife.

NATIONAL WILDERNESS PRESERVATION SYSTEM

2.709 The National Wilderness Preservation System was established by Congressional Declaration of Policy (Wilderness Act, 16 U.S.C. 1131-1136) and is designed ". . . to assure that an increasing population accompanied by expanding settlement and growing mechanization, does not occupy and modify all areas within the United States and its possessions, leaving no lands designated for preservation and protection in their natural condition."

2.710 The National Wilderness Preservation System is composed of federally-owned lands designated by Congress as "wilderness areas." An area which has been declared a wilderness ". . . shall continue to be managed by the Department and agency having jurisdiction thereover immediately before its inclusion in the National Wilderness Preservation System unless otherwise provided by Act of Congress."

2.711 In 1973, the Assistant Secretary of the Interior for Fish and Wildlife and Parks requested the Corps of Engineers' assistance in carrying out studies looking to the potential designation of certain Federal lands in the Upper Mississippi River National Wildlife Refuge as components of the National Wilderness Preservation System. Both Corps' lands in the Upper Mississippi River Navigation Project and Bureau of Sport Fisheries and Wildlife lands were being considered.

2.712 In response, the Corps of Engineers indicated agreement in principle that, consistent with the operation and maintenance of present and potential future navigation works, wilderness designation for some of the Corps' lands might well be desirable and in the best public interest. The Corps also expressed a willingness to consider proposals by the Bureau regarding Corps' lands that would meet the wilderness criteria. However, apparent conflicts have arisen between the Bureau of Sport Fisheries and Wildlife Wilderness proposal and the capability of the Corps of Engineers to operate and maintain the 9-foot navigation channel (refer to Section 3).

WILD AND SCENIC RIVERS ACT

2.713 According to an act of Congress (PL 90-542, Oct. 2, 1968) "the national wild and scenic rivers system shall comprise rivers that are designated as wild, scenic, or recreational rivers by or pursuant to an act of the legislature of the State or States

through which they flow . . . " The Lower St. Croix River Act of 1972 (PL 92-560) designated the lower portion of the St. Croix River as a National Scenic Riverway. The official designation was a result of a joint effort by the Department of the Interior, and the States of Wisconsin and Minnesota. Therefore, the lower portion of the river is presently a State-administered portion of the National Wild and Scenic Rivers system.

2.714 Under a master plan currently being prepared, no new commercial or industrial development will be permitted unless it is compatible with scenic preservation criteria and standards. It is also recommended that "a spoil disposal plan should be developed so that dredge spoil material from the 9-foot channel would be used to supplement existing beach areas or to establish additional recreation sites outside the floodway."

ROCK ISLAND DISTRICT

2.715 The Rock Island District of the U.S. Army Corps of Engineers is currently preparing an Environmental Impact Statement which will describe the impact of operation and maintenance of the 9-foot channel navigation project on the portion of the Mississippi River below lock and dam No. 10 at Guttenberg, Iowa, to mile 300 below lock and dam No. 22 near Saverton, Missouri. The reach extends 314 river miles and is considered "central" in respect to the St. Paul District and the St. Louis District.

2.716 Although the Upper Mississippi River and tributaries associated with the 9-foot channel project are being considered in reaches for the preparation of Environmental Impact Statements, this does not preclude later preparation of an overall impact statement for the entire project, nor does it preclude consideration of alternatives that may involve portions of the river outside of the section being considered within each Environmental Impact Statement.

2.717 Approximately 22 million tons of commodities were carried on the waterway in the Rock Island District in 1970. Principal commodities include grain, coal, petroleum products, and other items such as agricultural chemicals, cement and sand and gravel.

SECTION 3

3. Relationship of the Action to Land Use Plans

INTRODUCTION

3.01 The purpose of this section is to describe the relationship of the operation and maintenance of the 9-foot channel project to the existing and/or proposed land use plans, policies, or controls for the area affected by the operation and maintenance activities. This includes the ways in which the operation and maintenance activities conform or conflict with the objectives and terms of these plans, policies, or controls implemented by either Federal, State, or local governmental units.

3.02 The operation and maintenance activities are accomplished in general compliance with the Master Plans for Resource Management which the Corps of Engineers has prepared in coordination with Federal and State agencies, and other interests.

3.03 These master plans classify and identify the management objectives of the federally-owned land along the Upper Mississippi River. The management objectives for the Federal lands are set forth under the general categories of wildlife, recreation, and timber, with more specific objectives delineated within each category, and are generally compatible with adjoining or encompassing land use plans. The primary affected land use plans, policies, or controls fall under the Federal, State, or local categories of jurisdiction.

FEDERAL

3.04 The Federal plans, policies, and controls include general types of policies and regulations such as the National Environmental Policy Act of 1969, various Presidential Executive Orders, regulations of various Federal agencies, and other general legislation which may be applicable to the project area. More specific types of Federal plans, policies, and controls such as the Upper Mississippi River Wildlife and Fish Refuge, the Great River Road, the Wild and Scenic Rivers Act, the National Recreation Area, and the National Wilderness Preservation System relate much more directly with the project area.

3.05 The operation and maintenance activities are in compliance with national policies and directives and generally conform to objectives of the plans, policies, and controls of other Federal agencies. Several of the specific Federal plans, policies, and controls which appear to have, or may have, conflicts with the operation and maintenance activies follow.

UPPER MISSISSIPPI RIVER WILDLIFE AND FISH REFUGE

3.06 The operation and maintenance of the 9-foot channel project conflicts with several of the policies and objectives of the Upper Mississippi River Wildlife and Fish Refuge. The conflicts result primarily from the terrestrial and aquatic habitat degradation caused by disposal of dredged material. Other objectives of the refuge are enhanced by project operations, including maintenance of relatively stable water levels, increasing access points for recreational boat launching, financing of ecology orientated studies within the navigation pools, and the provision of the U.S. Fish and Wildlife Service with the opportunity to manage project lands. Several of the conflicts might be resolved by implementation of alternatives to present operation and maintenance activities such as revegetation of dredged material disposal areas, opening channels into backwater areas, and replenishment of recreational beaches.

THE GREAT RIVER ROAD

3.07 No major conflicts would occur with operation and maintenance of the 9-foot channel project and the Great River Road. A possible conflict could result from the viewpoint that areas of dredged material do not belong in a natural setting. The conflict could be primarily resolved by implementation of alternative techniques of dredged material placement and/or revegetation of disposal sites.

WILD AND SCENIC RIVERS ACT

3.08 The Wild and Scenic Rivers Act would not interfere with operation and maintenance practices of the 9-foot channel on the Lower St. Croix River. The volume of material dredged is at the present time small enough not to be a scenic or aesthetic detriment. In addition, dredged material could be utilized for beach recreation and/or enhancement.

NATIONAL RECREATION AREA

3.09 No direct conflict would appear to exist between the implementation of the proposed National Recreation Area plan and the current operation and maintenance of the 9-foot channel project. Areas designated as scenic and those areas which would be preserved in their natural state would undoubtedly have to be avoided when selecting future dredged material disposal sites. Recreational interests could be served by appropriate designation of dredged material placement for beach creation and/or enhancement.

3.10 The designation of wilderness areas within the Upper Mississippi River could affect dredged material disposal practices. It would appear most likely that disposal of dredged materials on such areas would be prohibited.

3.11 In January 1974, the St. Paul District Engineer, after reviewing Bureau of Sport Fisheries and Wildlife (BSF&W) proposals for the Upper Mississippi River Wilderness Area, recommended to the regional director, BSF&W, that designation of such a wilderness area be delayed until a solution to the question of dredged material disposal be found that is acceptable to both agencies. In brief, the District's position was that the Bureau's wilderness proposal limited areas for channel maintenance and dredged material disposal to narrow reaches along the channel. This would severely limit the number of alternative dredged material disposal sites at a time when alternative methods of handling dredged material are being investigated. Many of these alternatives, the District pointed out, involve moving dredged material away from the channel to remote locations or central locations that can be managed so as to create additional wildlife habitat or recreational areas or to serve as a stockpile for distribution of dredged material as a commercial commodity.

3.12 It is the opinion of the District that designation of a wilderness area on the Upper Mississippi River, where other uses not necessarily compatible with wilderness area criteria have been in existence for over 40 years, would not appear to be in the best public interest. Such action would inevitably generate additional management problems for all agencies involved. Those areas not currently under management by Federal and State agencies or not extensively used by the public would be naturally preserved for the future due to their remoteness and inaccessability.

3.13 In May 1974 the Bureau of Sport Fisheries and Wildlife conducted public hearings on the Upper Mississippi River Wilderness Study. A statement reflecting the views of the St. Paul District on the wilderness proposal was submitted to the record of those hearings. As the wilderness study proceeds in the future, the St. Paul District will continue to coordinate with the BSF&W.

STATE

3.14 The States of Iowa, Minnesota and Wisconsin, all have various land use plans, policies, and controls each differing slightly in content, interpretation, and enforcement. The general types of such regulations include preservation of wetlands, pollution abatement control, and floodplain management regulations. Areas where the States have more specific management objectives include areas such as the State forests, State parks, and State scientific areas.

3.15 There are or appear to be conflicts between the operation and maintenance activities of the 9-foot channel project and several of the various State regulations. For example, a Wisconsin statute prohibits dumping of pollutants into the waterways of the State and then goes on to define dredged material as a pollutant. Thus, wherever maintenance dredged material is placed within Wisconsin waters, there is a conflict with a general State land use policy. Although such general conflicts may occur, full consideration is given to State regulations, and they are complied with to the maximum extent practicable without jeopardizing the ability of the Corps to operate and maintain the 9-foot channel project. Coordination is maintained with the respective States to inform them of our actions and to obtain their views whenever possible regarding Corps activities.

3.16 The operation and maintenance activities of the 9-foot channel project do not normally conflict with any of the more specific State plans or policies, such as represented at the various State parks, State forests, and State scientific areas. Operation and maintenance activities are generally remote from these State areas and subsequently pose no conflicts.

LOCAL

3.17 The local plans, policies, and controls would tend to be of the more specific type which would be directed primarily at the relationship of that governmental unit to the Upper Mississippi River. The largest local governmental unit within the area affected by the operation and maintenance activities of the project is the metropolitan area of Minneapolis and St. Paul, Minnesota. The Metropolitan Development Guide for this area would be indicative of one type of local land use plan, policy or control. However, most smaller communities have less detailed guidelines.

3.18 The Recreation Open Space Policy Plan, the Water Resources Policy Plan, and the Protection Open Space Policy Plan of the Metropolitan Development Guide do not appear to have conflicts with the operation and maintenance activities of the 9-foot channel project. As with State plans, policies, and control, the Corps gives consideration to local regulations and conducts operation and maintenance activities so as to comply with these conditions to the maximum extent practicable. Dredged material is provided to communities free of charge if the disposal site is within the capabilities of the dredge plant. Often this material is then used as fill to assist in development of areas suitable for industrial and commercial growth. Dredged material is provided to these communities only after they have acquired the appropriate permits to allow disposal of material in specified areas.

SECTION 4

4. Environmental Impact of Operation and Maintenance

INTRODUCTION

4.01 The social, economic and environmental impacts of the present method of operation and maintenance of the Mississippi River 9-foot navigation channel within the St. Paul District are considered in this section. Operation and maintenance includes the maintenance dredging of the channel, the disposal of dredged material, the operation of the locks and movable dam sections, and the repair and servicing of the required electrical and mechanical systems.

4.02 Environmental, social and economic impacts also resulted from the original construction of the 9-foot channel project and creation of the pools. In addition, the Upper Mississippi River is a complicated, physical and biological system which is undergoing many continuous natural changes which are not attributed to the operation and maintenance of the 9-foot channel. These impacts and changes have been considered separately as a part of the existing environmental setting and, as such, are discussed in Section 2 of this report.

4.03 In order to maintain an appropriate perspective on the man-made and natural changes of the river system, the impacts of the present method of operation and maintenance of the 9-foot channel are, where possible, compared with the larger scale of natural changes which have been underway on the river since the ending of the geologic period of glacial melt, and with other phases of human activity on the river and its associated lands.

4.04 It is recognized in Section 2 of this report that the Mississippi River, subsequent to the period of glacial melt, had entered a period of floodplain deposition which was yet underway at the time the first modifications of the river for commercial navigation were made. As a result of the interdisciplinary studies made for this report, it is recognized that this dynamic situation in general is being modified by the presence of the 9-foot navigation pools and by the maintenance and operation in two basic ways as follows:

a. Greater rates of sedimentation and greater water surface areas than would be the case without impoundments are being sustained through the operation of the navigation dams; and

b. Urban growth in terms of transportation, manufacturing, processing, commerce, housing, and recreation is developing in such a manner as to utilize the aesthetic settings, navigation potentials and recreation resources provided by the existing project.

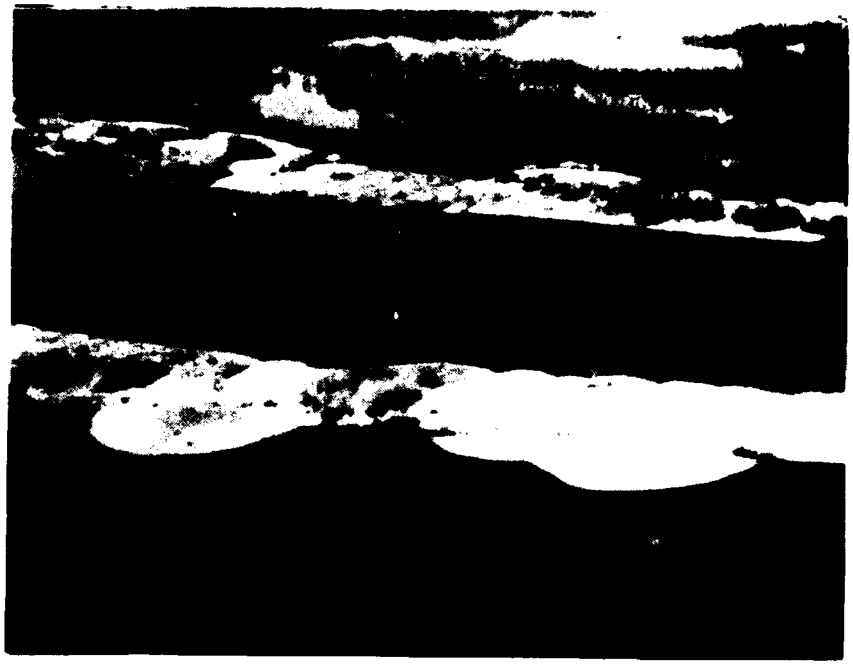
4.05 The concerns and controversies which surround the present and the future of the river and its associated lands are based upon the management of the various aspects of these natural systems and upon their ultimate fate as the river ages geologically.

IMPACTS ON GEOLOGY AND TOPOGRAPHY

4.06 The riverbed and floodplain of the Upper Mississippi are continuously undergoing considerable changes in geology and topography. The geologic period of floodplain deposition, as discussed in the Environmental Setting, is yet underway. This natural movement of material combined with the sedimentation phenomena induced by the original construction of the navigation project, is responsible for the majority of detectable changes. The actual maintenance dredging of the navigation channel results in bedload sediments from the main channel being relocated to one side or another of the main channel where they increase the extent of land in the off-channel area and change the bottom hydrography. From the year 1938 to the present, an average of about 2 million cubic yards annually of maintenance dredge spoil material has been moved from the navigation channel to side channel areas. Approximately 2,370 acres of dredge spoil sites have been identified (see Exhibit 173).

4.07 The spoil disposal areas assume a characteristic conical configuration. The hydraulically dredged spoil is pumped to the side of the navigation channel, and the apex of the cone is at the point of discharge. The slopes of the spoil material are approximately 1 vertical on 10 horizontal on the discharge side, and are about 1 vertical on 3 horizontal on the dredge side.

4.08 In plan view, as indicated in the following photograph for example, the spoil area may appear circular; however, due to overlapping dredge spoil deposits the circular appearance is cut off in the vicinity of the main channel or main channel border. This creates a semicircular-shaped aerial view, with the rounded margin encroaching on the off-channel side. In some cases, however, erosion may also affect the circular shape of the dredge spoil area.



Typical Appearance of Spoil Site

4.09 The accumulations of dredge spoil are subject to the same erosive forces which act upon the remainder of the river, its islands, banks, bottom, etc. Most of the spoil areas have eroded shorelines, and considerable wind erosion also occurs. In cases where this material is redeposited in the entrances to flowing sloughs as is described later for Wyalusing Slough, backwaters affected by decreased circulation are subject to increasing rates of eutrophication. On an overall basis, this action of both man and nature reduces the biological quality of the river system.

4.10 Although it is apparent that the guts of important running sloughs are being blocked by riverborn sediments, the degree to which maintenance spoil contributes to this problem is not entirely clear as of the time of this report. Since spoil deposition directly into such slough entrances is avoided as much as possible within the capabilities of existing equipment, it is probable that where dredge spoil is implicated in such problems, it is through erosion and subsequent redeposition of dredged material. The need for a more detailed and specific analysis of this problem has become more obvious as a result of this study, particularly in view of the very large quantities of material moving as a result of natural forces.

4.11 The blockage of the entrances to flowing sloughs is a special problem in the ecology of the river and some special cases are discussed under the impacts on Aquatic Vegetation and Animal Life later in this section. Small volumes of material can, and do, affect such large backwater areas as the Weaver Bottoms in pool 5. The reduction of circulation through such areas increases their tendency to function as nutrient sinks by reducing the flushing of nutrients. The areas affected become increasingly eutrophic.

IMPACTS ON SURFACE WATER HYDROLOGY

4.12 The impact of operating the navigation locks and dams is primarily to stabilize the stages and surface areas of the pools. The existing hydrologic system is actually becoming more stable (for discharge rates at which the river is being controlled) because of increased hydraulic efficiency of the main channel. The method of operating the dams requires that the lower portions of the pools be drawn down. Even though this requires that the stability achieved in the vicinity of the control point be achieved at the expense of increased fluctuation of the lower pool, the Anti-Drawdown Law previously discussed, and the increasing hydraulic efficiency of the main channel has made possible the minimization of pool drawdowns such that most drawdowns are now less than 1 foot. The resultant stable water levels are probably responsible for the extensive submerged aquatic vegetation in pools 7 and 8.

4.13 Navigation pools within the St. Paul District are regulated to maintain a relatively constant water surface elevation (project pool) at the primary control point of each pool. The location of the control point in a given pool determines where the most stable water levels will be, other areas in the pool will have some water level fluctuation. Rather strict regulation must take place so that these fluctuations do not cause flooding on private lands. Thus, regulation often does not provide the maximum benefit to fishermen, hunters and other recreationists in certain areas of the pool. There have been instances when hunting and fishing areas have been converted into mud flats by manipulation of dam gates. Recreationists on the river feel that their interests should receive consideration in the manipulation of water levels during any given period, and they are usually more concerned about low water conditions than they are about high water conditions. However, fluctuating water levels can also have adverse biological effects.

4.14 Special problems occur with drawdown in pool 10. The lower third of this pool is relatively shallow and the drawdowns result in the exposure of extensive areas of marsh and shore. The associated problems include adverse impacts upon marsh vegetation, reduced recreation access, and decreased aesthetic quality of the pool.

4.15 Operations associated with the dams have caused few adverse effects to the natural environment since the Anti-Drawdown Law became effective in 1948.

4.16 The operation of the project does not significantly affect the rate of flow. However, the flow patterns are being modified as the main channel becomes increasingly efficient. The flow of water into and through backwater areas has been reduced or eliminated under various circumstances. Many of these instances are attributed to the natural movement of sediments through the system, to roadway and other construction in the floodplain, or to disposal of maintenance dredge spoil. An example is the closing of a main feeder channel for the Goose Island area of pool 8 (Running or Bluff Slough, River Mile 697) which was closed during 1969 and 1970 as a result of floodplain construction, thus restricting flow into this area. Morman Slough, River Mile 695, is now the only large feeder channel for water supply into Goose Island. Although dredge spoil has been inadvertently placed in the entrances ("guts") of feeder channels for backwaters in isolated cases, the general practice in placement of dredge spoil is to avoid such areas.

4.17 Flow patterns during flood stages may also be subject to some modification where spoil banks have sufficient height and length to deflect current significantly. Some concern has been expressed that the erosion of dredged material from unstable spoil areas is causing the deposition of sediment in the entrance of running sloughs which provide circulation through important backwaters. Studies in this regard, however, are inconclusive at the present time, and the degree to which eroded spoil material is involved in the blockage of sloughs is not known.

4.18 Although there may be some local areas where water surface profiles may be raised due to continuous spoiling, generally, the operation and maintenance activities do not cause either significant increases in flood stages or greater flood frequency than would be the case without navigation improvements. As discussed in the description of the project (Section 1), the control gates are fully opened at flood stages and the river is uncontrolled. The increase in flood stage for this condition then would be similar to that caused by a bridge across the river and is limited to about one foot for large floods at the dam and diminishes to near zero at the control point. The possibility of providing flood protection through the storage of floodwaters has also been suggested occasionally. This would not be possible, however, because the capacity of the navigation impoundments is not sufficient. It has also been suggested from time to time that the placement of dredge spoil is resulting in increased flood stages. Hydraulic studies by the Corps have indicated that any increase in the Mississippi River profile due to sedimentation in overbank areas, over what would occur naturally without the navigation impoundment, is expected to be very small and occur only within the area between the pool control point and the downstream dam. There may, however, be some localized areas where continuous deposition of dredge spoil has caused an increase in water surface profiles.

4.19 A good way to explain how the dams function is by the following analogy, as quoted from the study on Effects of Navigation-Dam Operating Procedures on Mississippi River Flood Levels by the Iowa Institute of Hydraulic Research, University of Iowa:

> "Open river or natural flow conditions in the river, with the gates fully opened and the pools initially drained, correspond to the situation in which the faucet in the bathtub is turned on and the drain is open. The water level in the bathtub will rise to some height, perhaps as much as two or three inches above the bathtub bottom, depending on the flow rate, where it will remain. The flow rate from the faucet is then equal to that into the drain. Now let us represent the action of the navigation dam gates by a partial blockage of the bathtub drain. Provided that the blockage is not too great, the water level in the bathtub will rise until the tub is perhaps one-half or two-thirds full, at which time the depth of water is such that the flow rate out of the tub again equals that into the tub through the faucet. If nothing is done to disturb this balance, the water will remain at this level and the tub will not overflow. Now to simulate a large flood, imagine that a fire hydrant is brought into the bathroom and uncapped so that all the flow from the fire hydrant goes into the bathtub, and suppose that the flow from the hydrant continues for several hours. Suppose also that the partial blockage of the drain is removed after a short time when the water level in the tub reaches the three-quarters-full mark. This corresponds to the Corps of Engineers' gate-operating procedure. Under these conditions it is obvious that the bathtub will very rapidly become filled and begin to overflow. It stands to reason that the amount of overflow in the bathroom and the rest of the house after, say, one hour will not depend on the level of the water in the bathtub at the time the drain was unblocked."

4.20 Just as the capacity of the bathtub and the size of its drain are not sufficient to cope with the flow of the fire hydrant, the navigation impoundments and their outlet structures are not able to control the flood flows on the Mississippi River.

IMPACTS ON GROUNDWATER

4.21 Dredge disposal as presently practiced generally has no affect on the groundwater resources. The groundwater table is at or near the ground surface in areas used for disposal and rises and falls with the water surface elevation of the river. Any impact would be minor and of a very short duration.

IMPACTS ON WATER QUALITY

4.22 Although significant differences between the means of water quality parameters were detected along the pool transects studied during preparation of this report, the differences were not generally attributed to the operation or maintenance of the project. These differences were attributed rather to the presence of the impoundments of the 9-foot channel project and, as such, are discussed in Section 2. The most significant effects of operation and maintenance upon water quality are related to the aeration structures which have been constructed in response to periodic fish kills in backwaters below dike and spillways, and the turbidity generated during maintenance dredging. Less significant effects upon water quality include possible pollution sources such as bilge water, oil spills and other material spills, and turbidity resulting from the prop wash of towboats and recreational boats. However, these are secondary effects and are more attributable to the 9-foot channel project than to operation and maintenance.

AERATION OF BACKWATERS

4.23 Prior to the installation of aeration devices at most of the locks and dams, low oxygen conditions and nuissance algal blooms were frequent in backwater areas immediately downstream from the structures. During winter ice conditions, fish kills were common in these areas and there were objectionable odors during the summer season. At the recommendation of the U.S. Bureau of Sport Fisheries and Wildlife, aeration notches and culverts were installed, as appropriate at locks and dams 5, 5A, 8 and 10.

4.24 The regional director of the Bureau of Sport Fisheries and Wildlife reported to the St. Paul District Engineer by letter dated 20 May 1964, on the aeration devices which had been installed in locks and dams 5A, 5, 8, and 10 as follows:

> "Aeration facilities during the winter months serve to keep the backwaters ice-free for a considerable distance below the structure. This ice-free state assists the natural oxygenation processes. The amount of open water is influenced by the volume of flow and extremes of air temperature. Therefore, it is essential that capacity or near capacity flows (of the aeration facilities) be maintained during the winter months. With little or no flow through the structures, due to obstructions or closed water control gates, aeration facilities are of little value.
>
> Aeration facilities have improved the water quality and provided better winter conditions for fish life in the backwaters below Dams No. 5, 5A, 8 and 10. Capacity flows should be maintained at the gate-controlled aeration structures of Dams No. 5 and 8.

It is recommended that the St. Paul District Engineer modify the dikes and spillways of Dams No. 4, 6, 7, 8 (right submersible dam), and 9 to include aeration facilities similar to those installed at Dams No. 5, 5A, 8 (left submersible dam) and 10."

4.25 Subsequent to the report of 20 May 1964, the additional aeration facilities were installed at dams 4, 6, 7, 8, and 9. All of the aeration structures were constructed from operation and maintenance funds under the authority of correcting project deficiencies.

IMPACTS OF DREDGING ON WATER QUALITY

4.26 During the summer of 1973, a special dredge spoil study was conducted to determine the immediate effects of spoil deposition and dredging activity upon water quality in pool No. 8.

4.27 Forty stations were established in the immediate vicinity of a dredge spoil site near Crosby Slough and Crosby Island at River Mile 690.2. Benthic samples and water chemistry determinations were made prior to, during, and immediately after dredging. The WILLIAM A. THOMPSON was scheduled to deposit approximately 130,000 cu. yds. of material on Crosby Island. The water quality sampling stations were located upstream and downstream from the dredge spoil site. Each station was sampled four times. The first set of data (see Exhibit 187) was collected four days prior to dredging. The second and third sets of data were collected during the period when dredging was occurring. The fourth set of data was collected one week after completion of dredging.

4.28 A statistical analysis was made of the means of all parameters collected on each of the four days. Significant differences were noted between the means of the following parameters; temperature, turbidity, nitrate nitrogen, nitrite nitrogen, and dissolved oxygen.

4.29 No ecological significance is placed on the differences in temperature and dissolved oxygen, in the sense that they were affected by dredging. Rather, they are probably a function of diurnal changes and appear because the stations were sampled during different times of day. The turbidity increase however, was attributed to the operation of the dredge and tender boats in a rather confined area. The increased turbidity was directly observed at the site. The greatest contributor to the increase in suspended particles was probably the runoff of the dredged material from the spoil site.

4.30 The increase in nitrite nitrogen levels after dredging is also related to the activity occurring on the site. The source of nitrogen, however, was not identified. The ambient nitrogen levels in the channel areas where dredging occurred, was relatively low and probably cannot be accountable as the source of the increased nitrogen levels in the downstream water. However, the development

of a plant community on the spoil site during previous years has resulted in the accumulation of nitrogen in the poorly developed soils. Leaf litter and other forest floor materials have accumulated. It appears then, that the runoff of the dredge slurry from the site during dredging has leached some of these nitrogenous materials from the site and apparently has deposited it in downstream waters.

4.31 In summary, the effects of dredging on water chemistry at the Crosby Slough area appear to be localized. That is, significant downstream changes in the chemical parameters measured would not appear to have long term consequences. Dredging creates a local disturbance and the affected water quality parameters return to their pre-dredging status in a relatively short period of time. However, the direct, physical consequences of the placement of spoil are of a greater magnitude and are essentially irreversible. These impacts are discussed separately in other paragraphs of this section.

4.32 In addition to the immediate turbidity generated during dredging, spoil material is eroded to some extent by wind and water. This affects areas that are some distance from the spoil site as well as areas close to the spoil site. In the case of Crosby Island, the small channel (Crosby Slough) located just east of the spoil site has begun to fill with sediments from the runoff of the spoil material, and will probably continue to fill from future wind and water erosion. This is supported by the benthos data collected at the site during the summer of 1973. Samples collected before and after dredging indicate that there has been a significant reduction of organisms (by weight) at the most sensitive sites close to the spoil site. In particular, mayflies and clams and snails were the most affected. Obviously this was due to the overlaying of productive sediments with sand, rendering them unproductive.

IMPACTS ON LAND USE

4.33 Ownership by the Federal Government of the project lands is providing the authority and the resources for a larger unit of land use planning and land management than would be the case without the 9-foot channel project. The benefits of this larger unit include the following:

a. Maintenance of effective floodplain zoning to inhibit development of homes and businesses in flood-prone areas.

b. Provision of dependable public access and facilities for public recreation over a large area.

c. More efficient management of fish and wildlife resources than would otherwise be possible.

d. Interagency cooperation based on mutual use of land and waters.

LOCK AND DAM OPERATION

4.34 Since the present method of dam operation does not affect the flooding of lands upstream from the control point, the acquisition of lands in fee or easement in areas upstream from the control point is not necessary.

CHANNEL MAINTENANCE

4.35 The dredged spoil generated through the maintenance of the navigation channel is deposited alongside the channel, generally in either the channel border (which includes considerable wing dam habitat) or on existing low sand masses. The spoil frequently spreads out into off-channel areas affecting several types of shallow aquatic habitats such as marshes, floodplain lakes and ponds.

4.36 It is not possible to accurately determine, on an acreage basis, the extent of river habitat affected by any one influence, such as disposal of maintenance dredge spoil. The situation is complicated by natural erosion and sedimentation, by cultural influences such as land use in the contributing watershed, and by floodplain construction for bridges, etc.

4.37 In order to provide a basis for estimating the acreages of habitat directly affected by placement of dredge spoil, the known dredged spoil areas were determined from large scale aerial photographs (1 inch = 500 feet) taken in 1973. The spoil areas were identified on these photographs by following several guidelines:

a. Areas indicated by Corps of Engineers' dredge record sheets from 1956-1972 which identified disposal sites.

b. Photographic interpretation of conical shape sandy areas adjacent to heavy dredging locations, using the 1936-1972 dredging records as a guide.

c. Identification of selected spoil areas which could not be de-determined by either of the previous two methods through personal communication with personnel from the dredging plants. The majority of dredge spoil areas created by operation and maintenance activity of the 9-foot channel existing on the 1973 photographs should be accounted for.

4.38 The recognized spoil areas for each pool were allocated to various habitat types as indicated in Exhibits 174 through 186 under the headings of PRESENT HABITATS. The acreages of habitats existing prior to placement of dredge spoil were then estimated on the basis of the 1940 maps of the river, as indicated in the Exhibits under the headings, HABITATS BEFORE DISPOSAL. As indicated in Exhibit 186 a total of about 2,370 acres of spoil sites in the St. Paul District were identified. This is about 1.0 percent of the water surface area of all the pools. However, the full extent of areas

affected is not indicated because some of the spoil is under water or is obscured by woody or marsh vegetation.

4.39 On an overall basis, the habitat changes on the identified spoil areas include the loss of about 388 acres of shallow aquatic habitat and 953 acres of channel border. The aquatic habitat has been converted to about 763 acres of open sand-shoal, and 578 acres of lowland woods and brush. The obvious short-term trend is for aquatic habitat to be converted to open sand and for the open sand to eventually become overgrown with vegetation. Based on the estimates given in Exhibit 186, some 45 percent of the identified spoil deposits are presently vegetated to varying degrees with trees and/or brush. Within the remaining 55 percent, which was identified mostly as open sand and shoal, some herbaceous vegetation and grasses undoubtedly are present. Much of this is sparse, however, and could not be identified from the aerial photographs.

4.40 The disposal of spoil has caused the elimination of several islands. The joining of an island to the main bank reduces an especially valuable kind of edge or "ecotone" at the interface of aquatic and terrestrial habitats. Commercial or recreation development of the riverbank is generally stimulated under these circumstances. An example is Harriet Island Park in pool 2.

4.41 The disposal of spoil also affects the characteristics of the river bottom. Bottom irregularities and wing and closing dams are often converted to shallower areas of smooth sand. As indicated by Exhibit 186, nearly 60 percent of the identified spoil areas have affected channel border and shallow aquatic areas near the main channel.

4.42 Dredge spoil disposal also indirectly affects aquatic habitat in backwater areas by occluding the entrances to guts and side channels. When dredge spoil is implicated, it is usually the result of the secondary movement of the dredge spoil. Due to the confusing relationship between natural sedimentation and sedimentation induced by operation and maintenance activities, it is not possible to quantify these impacts at this time.

4.43 Secondary impacts of channel maintenance are difficult to ascertain and probably impossible to quantify. If a specific action somehow modifies the environment of a particular species so that the carrying capacity for that species is reduced, then a lower density population for the species will result within the affected area. Channel maintenance could affect a larger percentage of a species population than that occupying a spoil disposal area if a critical stage in the life cycle of that species were affected or a critical link in that species food chain were affected. For example, if dredge spoil disposal removed the food supply of a group of species

it would be obvious that the species would decline in numbers or be eliminated. A reduction of aquatic invertebrates would adversely affect those species of fish dependent upon them as a primary food source. It is impossible to state at the present time the number of species which may be affected in the above manner or the degree to which these effects may be occurring. Channel maintenance not only secondarily effects the natural resources of the river but also effects the utilization of those resources. The activites of channel maintenance may in some cases decrease the opportunity to fish, hunt, trap, and pleasure cruise due to degradation of habitat and/or blockage of access routes.

IMPACTS ON ENDANGERED OR THREATENED SPECIES OF ANIMALS

4.44 The effects of operation and maintenance on endangered or threatened species of animals are not actually known. However, a number of hypotheses have been put forth concerning the impacts on these species.

4.45 Channel maintenance could be affecting the threatened mussel, Lampsilis higginsi, which was formerly widespread in the St. Croix, Minnesota, and Mississippi (below the Twin Cities) Rivers. However, only one live specimen has been found since 1932 in the Mississippi River at Oquaqua, Illinois. In 1966 the survival of the species was considered threatened. Several individuals have recently been collected in Lake St. Croix at Hudson, Wisconsin. This same area is one of three in the lake which requires dredging. The significance of the effects of dredging on this species is not known.

4.46 Operation and maintenance may be affecting the threatened lake sturgeon. It is felt that these potential effects would be related to possible impacts upon spawning and feeding habitat of this species. Priegel and Wirth (Wisconsin DNR publication number 240-70, 1971) found that lake sturgeon in the Wolf River, Wisconsin spawned on rocky substrates, especially river banks reinforced with riprap. It is not known if lake sturgeon in the Mississippi River have the same habits as those in the Wolf River, however, an abundance of riprap is available in the wing dams, etc. Instances in which dredge spoil may have been deposited on lake sturgeon spawning habitat would have obviously resulted in an adverse impact upon that species. According to Priegel and Wirth, lake sturgeon feed upon benthic invertebrates in water less than 30 feet deep. Instances in which dredge spoil (either by direct deposition or secondary movement) may have covered productive bottom substrates would probably have resulted in an adverse effect upon this species.

4.47 It is not anticipated that other endangered or threatened species of animals would be significantly affected by the operation and maintenance of the 9-foot navigation channel. Some of these species, however, are affected by the 9-foot channel project and are discussed in Section 2, under the subsection Endangered, Threatened, and Locally Rare Plants and Animals.

IMPACTS ON TERRESTRIAL VEGETATION AND ANIMAL LIFE

4.48 Barren or sparsely vegetated spoil areas generally contrast with the surrounding dense floodplain woods, marshes, or open water, and can be readily identified from the air or from aerial photographs. However, the radius of the affected area extends beyond the superficially apparent margin of the spoil because vegetation and open waters may obscure the full extent of the area affected by spoil. Although the plant and animal ecology of dredge spoil sites is not well known, some observations are available upon the impacts of spoil placement and upon the biological development of spoil as discussed in the following paragraphs.

IMPACT ON TERRESTRIAL VEGETATION

4.49 Spoil disposal on land areas has resulted in the killing and stunting of many acres of bottomland forest. In many cases, natural revegetation of spoil areas has not occurred because of repeated deposition of spoil. Where woodlands have been subject to disposal but not with sufficient frequency to cause mortality, the trees have been partially killed or stunted and the understory has been lost. The tree canopy frequently remains intact in such instances and the spoil disposal site may appear to be unaffected in aerial view.

4.50 In response to partial burial by dredge spoil, the trees have frequently formed adventitious roots from the main trunk. Cottonwoods and willows form adventitious roots effectively.

4.51 The natural plant succession on sandy dredge spoil sites is generally slow due to a lack of nutrients, low surface moisture, and instability. Effects of evaporation and normal drainage produce a dry area on the uppermost 6 to 12 inches of the surface. Therefore, a dry, unstable area exists over much of the spoil area inhibiting the establishment of vegetation. Although moisture is available 6-12 inches below the dry surface layer, it is beyond the reach of germinating seeds. The moisture-free area undoubtedly increases in depth during dry periods, but is reduced again following precipitation.

4.52 In spite of limited moisture and fertility, rapid establishment and growth of vegetation does take place in some instances. Two distinct types of vegetative growth have been observed taking place almost immediately on the peripheries of spoil islands: seed or spore germination and vegetative reproduction due to stolons or rhizomes from previously established plants.

4.53 Edges of dredge spoil sites in contact with relatively calm shallow backwaters have in some cases demonstrated a prolific growth of cottonwood and willow sprouts. Herbaceous plants such as smartweeds (Polygonum spp.) and sedges (Carex spp.) are also common. The area of sprouting is limited in elevation to about 3 feet because constant moisture is only maintained to about this height by capillary action.

4.54 Vegetative growth due to the spread of stolons or rhizomes is apparently more common. Established species which are near the edge of a dredged pile or only partially buried may send up new sprouts. Cottonwood, willows, and some types of grasses and vines could invade a newly deposited spoil pile in this manner. This is generally a slow process of unknown importance. Willow and cottonwood are important colonizers of newly exposed soil. Willow requires continually moist soil and is more likely to be established near the water. Cottonwood is relatively drought resistant and once established is more likely to be present further away from water.

4.55 While recovery by sprouting and seed germination is possible in the open sites or in willow-cottonwood stands, it is difficult or impossible in the stands of mature elm, maple, and ash. The normal early colonizers of sand are shade intolerant and do poorly in the shade cast by the mature trees. The seedlings and saplings with normally low densities in these mature stands are most susceptible to damage from spoil deposition. Commonly the result of spoil deposition is the removal of the successional understory. Death by disease, such as Dutch Elm Disease, or normal senescence of the remaining overstory can result in the complete elimination of mature bottomland forests. Normal successional patterns are distorted, resulting in the development of new disclimax of questionable value.

4.56 Development or ecological succession of vegetation on spoil sites apparently proceeds through mature floodplain forest consistent with surrounding sandy islands. However, maintenance dredging on the river frequently involves repeated placement of spoil on some sites. Where this occurs, the development of vegetation is prevented or retarded.

IMPACTS ON TERRESTRIAL WILDLIFE

4.57 Following maintenance dredging and spoil deposition the characteristic animal life of the bottomland woods is either buried under the spoil deposits, driven from the vicinity, or, in the case of forms which utilize a given area only at specific times, fail to occupy the area after the habitat is lost. The smaller and less mobile forms which would generally be buried include soil invertebrates, insects, and small mammals. Since much of the maintenance dredging occurs during the spring, the young of mammals such as rabbits and the eggs and nestlings of birds such as waterfowl and sandpipers are also probably affected. The larger more mobile forms of adult animal life such as deer and birds are able to flee the area prior to disposal. However, the loss of habitat may require that the displaced forms compete among themselves and with other species of wildlife for limited habitat. This kind of competition eventually leads to a reduction in the numbers of the affected species. However, the ecological succession of vegetation on spoil sites is also creating habitat for other forms of wildlife such as song birds and turtles.

4.58 Less is known about the recolonization of spoil sites by wildlife. At the earliest stages of bare sand, the sites are important in the nesting of turtles and feeding by sandpipers. Waterfowl nesting occurs at a relatively early stage of plant succession. Nests of waterfowl such as teal and mallards are found in the fringes of willow which form near the shores of spoil sites.

4.59 Sign of such predatory mammals as skunk and fox are present on many spoil islands, and special predation-prey relationships apply. The narrow fringes of willow brush which develop near the shoreline attract nesting birds but provide efficient hunting territories and are frequently located near dead or dying trees which serve as perches for predatory birds. Therefore, the eggs and young of waterfowl and other birds become easy prey. The smaller, isolated islands of dredge spoil, as is the case with natural islands, are less likely to be occupied by mammal predators. Therefore, they are somewhat safer for birds, turtles, and other nesters.

4.60 Although spoil disposal results in adverse effects due to the killing of large floodplain trees, it also provides perches for predatory and other birds while dead wood provides habitat for insects. The insects in turn develop into a food base for woodpeckers and small mammals.

4.61 It is noted that the largest black-crowned night heron rookery in the State of Minnesota is located in pool 2, however, this site is not affected by the disposal of maintenance dredge spoil by the Corps of Engineers.

IMPACTS ON AQUATIC VEGETATION AND ANIMAL LIFE

4.62 The extensive aquatic biological systems which were created by the construction of the 9-foot navigation project are subject to major impacts by the operation of the dams and by the maintenance dredging of the channel. The impacts of lock and dam operations on aquatic systems are related primarily to this overall stabilization of water levels, while the impacts of channel maintenance are related primarily to the loss of aquatic habitat at spoil disposal sites. Losses or changes in aquatic habitat of backwater areas are indirectly affected by spoil deposition (usually secondary movement of spoil) which can result in disruption of flows and sedimentation. The quantification of indirect affects of spoil deposition is complicated by naturally occurring sedimentation.

POOL OPERATION

4.63 Pool drawdowns (see discussion in Section 1, Description of Major Federal Action) are for the purpose of maintaining the most stable water level conditions possible in the vicinity of the designated control point. Since the control points are generally located within the middle 1/3 of the pool and since most of the slough and

marsh habitat tend to occur within this same area, these habitats are subject to less water level fluctuation than are the upper and lower pools. The maintenance of a relatively stable water surface elevation in the middle pool enhances the variety or diversity of aquatic vegetation and this is of benefit to many of the more prominent and appreciated forms of aquatic animal life. Some of the more important ecological relationships which are enhanced by this situation include the availability of marsh vegetation for spawning of northern pike, and food as well as house building materials for muskrat. The growth of dense beds of aquatic plants also provides feeding areas and cover for the panfish which contribute both to the sport fishery forage base and the sport fishery. Because recreation use of the marsh area tends to be low during the spring growing season, the recreation user population is controlled and dispersed in a manner which tends to protect some of the more ecologically sensitive areas from excessive direct contact by man. Protecting waterfowl breeding and nesting areas which are utilized for food and cover are important in this respect.

4.64 Most of the lower pool areas are essentially lake-like with sufficient water depth that most of the plant and animal life are not seriously affected by the approximately 1-foot drawdowns. However, the much greater drawdowns of up to 4 feet, which formerly occurred did result in severe adverse biological effects.

4.65 The upper pools are similar in general appearance and biology to the river as it existed prior to the 9-foot project. There are substantial impacts, however, which can be related to the dam operation. The concentrations of fish below locks and dams, for example, is probably related to the oxygenation of the outflows, and the rich supply of forage organisms drifting downstream from the pool above.

4.66 In pool 10, there is considerably more slough and marsh type habitat in the lower area than is the case with any of the other navigation pools. Because of this, the periods of drawdown reduce the overall variety of the aquatic vegetation and cause special problems, particularly during the seasons of fish spawning and waterfowl hunting. Much of the marsh habitat, which the U.S. Bureau of Sport Fisheries and Wildlife estimates at about 5,675 acres in this particular pool, is at or below the established secondary control point located near the town of Clayton, Iowa, river mile 625. These marshes are subject to considerable exposure during periods of drawdown which occur on the order of two to four times per year. The forms of vegetation which are able to withstand exposure such as arrowhead, cattail, and certain of the bulrushes, tend to survive under these circumstances while less resistant forms tend to be eliminated. The vegetation, therefore, develops into what ecologists refer to as "monotypic assemblages" or large areas dominated by a single form of vegetation.

4.67 It has not been possible as of the present to control the time of drawdown for the benefit of waterfowl - such as for the purposeful production of millet, smartweed, or cyperus as discussed by Bill Green and others in the U.S. Department of Interior book publication entitled, "Waterfowl Tomorrow". This is because rising stages on the river do not generally occur at times of the growing season during which drawdown would benefit the production of food for waterfowl.

4.68 Opinions among aquatic biologists vary somewhat as to whether or not the locks and dams are significant in blocking the movement of fish and other aquatic life. Most biologists indicate, however, that considerable numbers of fish do pass through the dams at high water and the operators indicate that fish passing through the lock chamber are occasionally killed or crippled. It is also generally accepted that the construction of the dam at Keokuk, Iowa, has had an adverse effect upon the migration of certain fish species.

CHANNEL MAINTENANCE

4.69 The biological impacts of channel maintenance activity are related to the placement of dredge spoil and the hydraulic cutting process by which materials are removed from the bed of the main channel. However, it is not possible to completely isolate the impacts of channel maintenance from the natural movements of sediment and the erosion and turbidity resulting from the movement of barge tows.

4.70 The maintenance dredging may be responsible in part for the absence of benthic organisms in certain parts of the main river channel. In general, however, the main channel bottom consists of steadily moving bedload sediments which do not form a suitable substrate for the development of bottom organisms. In addition to the natural movement of sediments, the sterile conditions of the channel bottom are also due to disturbance by the propellors of the larger barge tows, and surface water pollution.

4.71 In areas where channel maintenance operations are responsible to a significant degree for the absence of bottom organisms, the effects are due mostly to the turbidity generated by spoil placement. Turbidity generated at the cutterhead is regarded as relatively insignificant, especially when compared to the turbidity generated by spoil placement.

4.72 The turbidity generated during maintenance dredging spreads beyond the disposal site and lasts longer than the dredging period (see Exhibit 187). As an example, turbidity in the Minnesota River pool has been observed to be tripled 100 feet downstream from the clamshell. At 0.8 mile downstream it is still nearly double the turbidity measured upstream from the dredge (see Exhibit 188).

4.73 The burial of vegetation and animal life is one of the most significant known direct biological impacts of placement of dredge spoil. Based on specific studies for this report, it is estimated that some 1,300 acres of aquatic systems (see Exhibit 186) have been directly affected by maintenance dredge spoil disposal during the life of the 9-foot navigation channel. This includes several types of shallow aquatic habitat, and channel border which are especially important to the production of aquatic invertebrates. The estimated acreages of habitat types subjected to direct burial by spoil placement are given in Exhibits 174-186.

4.74 Dredged spoil material placed in aquatic habitats results in direct losses of aquatic vegetation and invertebrates which are buried and subsequently smothered. Their actual loss is irretrievable and new colonization on submerged dredged material probably does not occur to any significant degree in the short-term. This is because the nature of the aquatic substrate is generally converted from relatively productive organic sediments or rock-rubble to relatively unproductive sand.

4.75 The ecological colonization of such areas may, in any event, require several years. Mollusks have been reported to require 10 or more years to recolonize dredged areas. The comparative situation between dredged and undisturbed areas is indicated in part by recent studies where 13 species of mussels were found in the vicinity of Fort Snelling. The same area in the 1880's was found to yield 27 species. Such findings are not, however, completely indicative of the impacts of maintenance dredging.

4.76 The mussel data may indicate impacts of the original implementation of the project rather than its operation and maintenance. In addition, the river has been in the past and continues to be subject to many other environmental influences such as sewage and storm drainage, changing land runoff, thermal effects of power plants, and heavy boat traffic.

4.77 Dredge spoil also contributes to the blockage of flows through backwaters. This is a major problem with dredging in pool 10. Wyalusing Slough, on the Iowa side (river mile 627.7) supplies flow to a 3,600-acre backwater which permits boating access from the Sny Magill Addition of Effigy Mounds National Monument, to the river. At the entrance to Wyalusing Slough, just below the mouth of the Wisconsin River, a combination of natural sedimentation behind the wing dams and a dredge spoil dump in 1968 almost entirely cut off flow. This could have blocked river access to a National Monument and the only boat ramp on the Iowa side of the river between Clayton and McGregor.

4.78 The flow of water through Weaver-Lost Island area of pool 5, which has been affected by the placement of dredge spoil and by natural sedimentation, has been losing its value as fish and wildlife habitat to an accelerating degree during the past 15 years. The changes that have taken place are obvious to every observant hunter, fisherman and boater who uses the area. Duck marshes have been filled with sediment in some areas, small boat channels have been occluded and floodplain lakes have been stagnated.

4.79 Flow of water through the Weaver Bottoms has been virtually stopped by a combination of the accumulated islands of dredge spoil along the lower end of Weaver Bottoms, the sanding in of West Newton Chute and the occlusion of the unnamed slough which connects West Newton Chute and Half Moon Lake, as shown in the photograph on the following page. The changed flow patterns in the Weaver Bottoms are probably responsible, in part, for the demise of the extensive stands of the emergent aquatic grass Phragmites. The loss of the resultant wind and wave action has increased turbidity and caused a reduction in beds of other valuable aquatic plants.

4.80 Few openings are left in the spoil barrier which flanks the Weaver Bottoms. Suspended sediment, which enters the bottoms during high water tends to settle out in the lake-like environment. However, this channelization effect also results in a more efficient channel which confines the transport of bedload sediments which would otherwise tend to seek new channels into backwater areas.

4.81 In other cases, the sedimentation of backwater areas has occurred in the absence of direct placement of spoil as described below for Gibbs Slough.

4.82 During the summer of 1928, the noted limnologist, Eugene W. Surber, began a general survey of the sloughs, natural ponds and lakes in the bottomlands of the Upper Mississippi River Wildlife and Fish Refuge. The purpose of the survey was to discover natural ponds and sloughs which could be converted into fish rearing ponds, and to obtain basic biological information about the sloughs. Surber described his study areas quite thoroughly and it was possible to visit two of them in pool 6 during the summer of 1973.

4.83 The changes which had taken place in his Gibbs Slough station were most extraordinary. Surber's description of the area is as follows:

> "Location: Opposite Trempealeau, Wisconsin, is Island No. 81, Minnesota side of the river. This slough is completely isolated from the river and is only invaded by it during very high water. It is 1,125 feet long and has an average width of 104.6 feet (area about 2.82 acres). It averages about 5.5 feet through the middle or deepest part. The banks on the

1973 Corps of Engineers photo showing how circulation of water through Weaver Bottoms has been impeded by dredge spoil and other obstructions.

west shore of the slough slope off rather quickly into the deeper water. The slope of the right shore is more gradual. Silver maples, green ash, and willow trees are found on the high banks of the west shore ... a rich growth of submerged vegetation occurs in the shallow water regions along the east shore."

4.84 Subsequent to Surber's study, the area was inundated by 6 feet of water with the filling of pool 6. For a few years, the water depth in Gibbs Slough must have exceeded 11 feet. When the writers visited the area in 1973, the stumps of the trees which once rimmed the slough were still evident. Large sand deposits, however, had filled the area (see following photograph) and had risen above the level of the stumps in most places. Navigation through Gibbs Slough was impossible with an outboard motor boat, the water in most areas being ankle deep. It was obvious that the deepest portions of Gibbs Slough have filled to a depth of over 10.5 feet with sand - even though available dredging data shows no record of spoil deposition within the slough or at a site from which secondary movement of spoil would be a significant sediment source.

4.85 Although natural sedimentation is the likely source of the material filling Gibbs Slough, the change from slightly modified open river condition at the time of Surber's visit to essentially slack-water conditions following construction of lock and dam 6 was probably the primary factor in altering natural sedimentation patterns and the subsequent filling of the slough. The navigation channel and wing dams also may have contributed to the sedimentation changes.

IMPACTS ON RECREATION

4.86 The disposal of dredge spoil provides a benefit to recreation through the creation of extensive sand beaches in all pools. Although very little development of sanitary facilities, drinking water supply, or other recreation user needs has been undertaken as of the time of this report, the beaches receive heavy use during the recreation season. The present situation warrants a study to determine the level of facility development which would be required in order to provide adequately for present use and also to estimate future use and needs. Such studies would provide a basis for needed future development of recreation facilities. The most superficially apparent need at the present time is for proper collection and disposal of trash. Scenes such as indicated in the photograph on page 227 are representative of accumulation of trash on dredge spoil sites.

Surber's seine haul station in Gibb's Slough. Prior to impoundment the slough was 5.5 feet deep. This off-channel area has filled with over 10 feet of sand though it has never received dredge spoil.

Improperly Disposed Trash on Spoil Site

4.87 Recreational utilization of spoil sites is enhanced by the gradually sloping shoreline on beach-like contours. In some cases, however, severe erosion due to excessive current or wave action has occurred. The shorelines have sometimes demonstrated slopes in excess of 45° which minimizes potential recreational use.

4.88 The reduction of recreation boating access through the blockage and filling of backwater areas is frequently attributed to the disposal of dredge spoil. Engineering hydraulic and hydrologic studies conducted during the preparation of this statement indicate that natural erosion and sedimentation are also involved in this process.

4.89 Sand Run, across from Weaver Bottoms in pool 5, until a few years ago, was a much-used access to Buffalo City. The run is now impassable, except during high water, because of sand accumulation. Other passages to Buffalo City are also filling rapidly and it is evident that the resort area will soon be isolated from the main channel during low water.

4.90 It has been recommended by some that Sand Run be dredged to permit its original flow and that other openings also be dredged through the barrier islands into Lost Island and Weaver Bottoms. A more detailed and comprehensive study of backwater channel blockage, including the possible impacts of dredging openings into selected backwater areas is needed before this situation can fully be understood.

PUBLIC HEALTH AND SAFETY

4.91 The public health and safety of river users is potentially affected by operation and maintenance primarily as a result of the passage of recreation craft through the locks and through the public use of dredge spoil sites for undeveloped recreation.

4.92 A number of potential safety hazards have been observed at the locks and dams and the existing system of priorities for passing boats are intended, in part, to protect public safety. The possibility of collision between recreation and commercial craft is minimized partly through the commitment of the lock to an oncoming barge tow at a time when the barge remains some distance away. In a few cases where recreation boaters have entered the locks in spite of an oncoming tow, accidents have nearly resulted. Boaters are also instructed to remain 100 feet from dam sections on the downstream side and 600 feet from the upstream side. Alternative means of passing recreational craft at the locks is discussed in Section 6, Alternatives.

4.93 The beaches which are formed by dredge spoil seldom are provided with sanitary facilities. This implies that sanitary wastes may easily enter the surface water where some probability of disease transmission exists. The development of minimal facilities to provide for the public health is a definite need in this regard.

ECONOMIC

4.94 Major direct economic benefits of the 9-foot navigation project that are realized through continued operation and maintenance are attributed to the continued low-cost transportation of commercial bulk commodities on the river. Important economic benefits are also generated by the recreation on the river, especially boating oriented activities. The secondary economic effects are widespread throughout a large portion of the United States.

4.95 Exhibits 104 and 105 show the growth of receipts into and shipments from the St. Paul District in the 30 years from 1940 to 1970. Commodities shown in the figures illustrate the diverse economic activity within the St. Paul District. This diversity also applies to the commercial docks in the pools that handle coal, sand, gravel, salt, fertilizer, and grain. Although receipts in the St. Paul District still substantially exceed shipments, the growth in shipments (89 percent grain) from the District in these three decades indicates the great impact of the river on the regional economy.

4.96 In 1973, in conjunction with the Mississippi River year-round navigation study, projections (based on 1970 data) were made of the growth of commerce in the St. Paul District which are shown in Exhibit 106. The projections suggest that the tonnage of barge traffic moved in the Upper Mississippi River basin will increase significantly in the next 50 years.

4.97 It is noteworthy that receipts into the St. Paul District have always exceeded shipments. In earlier years this imbalance was often extreme (e.g., 1953 receipts = 3,052,144 tons, shipments = 334,233 tons). Recently however the ratio has been around 2 to 1. Inasmuch as grains and soybeans constitute the preponderant tonnage of

shipments, fluctuation in waterborne transport of these products can be profound due to crop conditions and storage facilities, foreign sales, and competing forms of transportation.

4.93 Operation and maintenance of the locks and dams requires a work force of 153 full-time personnel. An additional 29 personnel are required on a seasonal basis during the peak summer period. Present dredging operations employ approximately 66 personnel on the DREDGE WILLIAM A. THOMPSON and 33 on the DERRICKBARGE HAUSER. A minimum security crew is maintained on board the DERRICKBARGE HAUSER during weekends and on both dredging plants during the winter months.

HISTORICAL AND ARCHEOLOGICAL

4.94 The original construction of the 9-foot navigation project is known to have affected a number of sites having historical or archaeological value. The operation and maintenance of the project, however, does not directly affect any historical or archeological site so far as is presently known. Operation and maintenance was in a few instances having an indirect effect upon access to special sites. This latter factor is the major problem with dredging in pool 10. Wyalusing Slough on the Iowa side (mile 627.7) supplies flow to this entire backwater area, (3,600 acres) and regulates water levels to permit boating access from the Sny Magill Addition of the Effigy Mounds National Monument to the river. At this point in the main channel, just below the mouth of the Wisconsin, a combination of natural sedimentation behind the wing dams and placement of dredge spoil in 1968 almost entirely cut off flow into Wyalusing Slough. This could have blocked river access to a National Monument and the only boat ramp on the Iowa side of the river between Clayton and McGregor.

FOSSIL FUELS AND OTHER ENERGY SUPPLIES

4.95 Operation of the structures during fiscal year 1973 required approximately 460,000 kilowatt hours of electricity and approximately 2,500 gallons of diesel fuel. "The WILLIAM A. THOMPSON uses about 340,000 gallons of No. 2 diesel fuel per year while the DERRICKBARGE HAUSER uses about 25,000 gallons per year."

REMEDIAL, MITIGATIVE, AND PROTECTIVE MEASURES

4.96 The remedial, protective, and mitigation measures which are being done in conjunction with the existing method of operation and maintenance include selective placement of maintenance dredge spoil, aeration devices which have been installed at the locks and dams, and reduction in pool drawdowns.

4.97 The placement of dredged spoil is presently coordinated with the U.S. Bureau of Sport Fisheries and Wildlife and other natural resource management agencies, within the limits of the available dredging equipment. The deposition of spoil into the entrances (guts) of running sloughs is avoided. Based on this coordination and consultation the spoil is placed in the least environmentally damaging of the possible disposal sites. About an additional $100,000 annually is incurred in placing the dredged spoil in these designated areas rather than the sites that would be utilized under the least expensive means.

4.98 The Upper Mississippi River Conservation Committee (UMRCC) has also cooperated with the Corps of Engineers for a number of years in finding areas to place dredge spoil material generated from maintenance of the commercial navigation channel in the Upper Mississippi River. Chronic dredging areas were determined and sites for placement of spoil materials were suggested based on the limitations of the existing dredging plant. Such efforts led to the preparation of cooperative UMRCC survey reports, the last of which was entitled the "Upper Mississippi River Dredge Spoil Survey - 1969", as prepared by the Fish Technical Section of the UMRCC. Sites were designated where spoil placement would be "least destructive".

4.99 Since the 1969 survey report was prepared, several social and physical changes have occurred on the river which tend to both nullify many of the recommendations and complicate the dredge spoil issue. The UMRCC has officially rescinded the 1969 report.

4.100 The aeration devices which have been installed at locks and dams 4, 5, 5A, 6, 7, 8, 9, and 10, have improved water quality and provided better winter conditions for fish and other aquatic life in the backwaters below the dams. The aeration culverts and notches were developed under the close cooperation of the Corps and the U.S. Bureau of Sport Fisheries and Wildlife.

4.101 The reduction of pool drawdowns is another protective measure which was implemented on the 9-foot project. Moderation of water level changes as required by the Anti-Drawdown Law, has been of considerable benefit to fish and wildlife.

SECTION 5

5. Unavoidable Adverse Impacts of Operation and Maintenance

5.01 This section discusses the detrimental or adverse aspects of the operation and maintenance of the 9-foot navigation channel which cannot be eliminated without sacrificing the authorized function of the project.

5.02 The most significant direct adverse impact of the present method of operation and maintenance of the 9-foot navigation project is the conversion of aquatic and semi-aquatic habitats to sandy shoals or islands as a result of the placement of dredge spoil. The affected aquatic habitats consist mostly of main channel border, including many of the pre-9-foot channel wing and closing dams, and adjacent shallow waters or wetlands. Fish, wildlife, and public recreation values associated with this aquatic habitat are reduced by the placement of the spoil. Conversion of terrestrial habitat values also takes place on at least a short-term basis, with natural habitat being replaced usually by a sandy area of lesser wildlife value.

5.03 Since the maintenance of the 9-foot navigation channel requires dredging and the disposal of spoil, it is impossible to avoid some form of habitat conversion without sacrificing the authorized purpose of the project. The specific area affected and the amount and type of habitat conversion, however, depends upon the capabilities of the dredging plant, the methods used, and the quantity and type of material to be dredged.

5.04 Fish, wildlife, and recreation interests have frequently expressed and publicized the opinion that spoil deposits are being eroded and then redeposited in the entrances of running sloughs or feeder channels which provide for the circulation of fresh, oxygenated water through extensive backwater areas. Information which is available at the time of this report indicates that many backwater sloughs and river lakes and ponds are gradually being isolated from the flow of the river. This isolation however, is attributed to the natural movement of sediments and various kinds of floodplain construction, such as bridges and roads, as well as to the placement and secondary movement of maintenance dredge spoil. The degree to which any one kind of sedimentary phenomenon is responsible for the isolation of backwaters remains unknown at the present time.

5.05 Placement of dredged spoil from channel maintenance results in the unavoidable creation of some barren sand spoil sites. Even with the implementation of a major plan of revegetation of spoil sites (see discussion of alternatives in Section 6) there would remain considerable demand for the maintenance of sand beaches along the river. It would probably also be desirable to maintain certain areas and shorelines of open sand for specific wildlife needs - as, for example, in the case of the nesting turtles on Turtle Island in pool 8.

5.06 The turbidity generated during spoil deposition is essentially unavoidable without the construction of confinement structures. Such confined disposal areas, especially if designed to provide retention and desilting of effluent waters would continue to take up valuable biological areas and could detract from the aesthetic setting of the areas.

5.07 The turbidity spreads beyond the immediate maintenance site and drifts downstream burying some aquatic organisms and causing abrasive damage to the respiratory organs of others. The turbidity has, for example, in the Minnesota River been observed to be tripled 100 feet downstream from the point of dredging, and 0.8 mile downstream, to be nearly double the turbidity measured upstream of the dredge.

5.08 The upper pools, which are in the vicinity of the Minneapolis-St. Paul metropolitan area, are inclosed in a narrow, high-walled gorge and are subject to a severe constraint, regarding sites for disposal of dredge spoil. In these areas, the constriction of the river channel is unavoidable in terms of any presently contemplated system of spoil disposal other than those involving transport of the spoil over very long distances.

5.09 The increasing probability of spills from barge transportation is regarded from some viewpoints as an unavoidable consequence of the operation of the project. Such spills, however, appear to be more dependent upon the rates of barge transport and are, for practical purposes, not taken as an impact of the operation and maintenance of the project. However, these and other similar impacts are attributed as secondary effects of the 9-foot channel project, and as such, are discussed in Section 2.

SECTION 6

6. Alternatives

INTRODUCTION

6.01 Alternatives to the existing method of operating and maintaining the 9-foot channel navigation project are discussed in this section. Three broad alternative categories have been identified as follows:

a. Cease all operation and maintenance activities.

b. Provide a navigation channel of lesser or greater depth than 9 feet.

c. Provide a 9-foot navigation channel with modifications to the existing operation and maintenance activities.

6.02 The first two alternative categories consist of major changes in the primary objectives of the operation and maintenance activities and, since they are in opposition to the directives of Congress, they will be discussed in less detail than the third alternative category which retains the primary objectives.

CEASE OPERATION AND MAINTENANCE OF NAVIGATION CHANNEL

6.03 Ceasing the operation and maintenance activities associated with the 9-foot navigation channel project would consist principally of cessation of all the activities described in Section 1 of this Environmental Impact Statement. With discontinuation of funding for operation and maintenance of the project, the structures would have to be either eliminated or fixed in such a manner so as not to constitute a hazard to public health, safety, and well-being. Without maintenance the structures would eventually fail due to non-repair. Dredging of the navigation channel would cease.

6.04 Implementation of this alternative would have several dramatic effects, principally to the socioeconomic status of the regional economy and to the natural environment of the Mississippi River valley. The commercial navigation would be greatly reduced on the river with the main channel depths becoming unreliable, especially during the lower flow periods of the year. Attempts at commercial navigation would probably be limited to the high water periods, and even then an uncertain depth would limit the profitability of such use. The potential for increased accidents and grounding of vessels using the river in this condition would exist, as would the potential for an increase in spills of oil and other hazardous substances due to these accidents. If barge traffic were to cease, these potential

groundings, accidents, and spills would also cease. There would be a transfer of shipment of the commodities currently carried by barge traffic to other modes of transportation. Initially there would be severe shortages of facilities to accommodate the large amount of freight currently handled by the waterway, however, as the alternate modes of transportation increased their handling capabilities, these shortages of facilities would be eliminated. There would no longer be the need of an annual expense of about six million dollars to operate and maintain the waterway within the St. Paul District. There would be lost investments to firms with facilities located to best utilize the transportation and shipping opportunities provided by the navigation channel. Additional cost would be incurred to remove or modify the structures, and there would also be lost investments in the project structures and other facilities associated with operation and maintenance of the project. Recreational use opportunities would be reduced along the river due to the decrease in water surface area, as well as recreation facilities associated with the project.

6.05 The environmental effects and impacts of this alternative would also be profound. The control of water levels in the pools would be eliminated and the area of aquatic habitat would be significantly reduced. Elimination of dredging would reduce the rate of replacement of valuable wildlife habitat with sandy bedload sediment much of which is currently attributable to maintenance dredging activities. Additional information regarding the general type and magnitude of these and other impacts are brought forth in the Environmental Setting section of this statement (Section 2, under the heading "Future Setting without Operation and Maintenance Activities"). Implementation of this alternative would require a major change in the primary objectives of the project and would have such a great impact on the present socioeconomic and environmental setting that it could be considered a socially highly undesirable alternative.

OPERATE AND MAINTAIN OTHER THAN A 9-FOOT NAVIGATION CHANNEL

6.06 Operation and maintenance of other than a 9-foot navigation channel could provide for a channel of either lesser or greater depth. A shallower depth channel could be maintained by either reducing the depths of dredging, lowering the water levels in the pools, combinations of both, or by some other method involving different types of structures, such as a reversion to the wing dams and closing dam of the earlier maintained 4 1/2-and 6-foot channel projects. A greater depth channel could be provided by either raising the water levels, increasing the depths of dredging, or combination of both. A project similar to the controversial 12-foot channel project which was being studied by the Corps of Engineers for the St. Paul District would be an example of one type of deeper navigation channel.

6.07 Implementation of either of these alternatives would cause major socioeconomic and environmental impacts, the magnitudes of which would vary with the depth of channel maintained and the methods utilized for and in its operation and maintenance.

6.08 Reductions in the depth of channel maintained would probably involve greater costs involved in utilizing the waterway for shipment of bulk commodities due to decreased efficiencies obtainable with the equipment utilized on the present waterway.

6.09 Other socioeconomic impacts similar to this would occur, the magnitude and type of which could be similar to those described in the "Cease Operation and Maintenance" alternative. Environmental impacts could probably be reduced from those of the present system if dredging were reduced and the water levels and regulating structures were maintained similar to their current operation and condition. Reduced amounts of material would be handled by the dredge. If the water levels were lower, however, environmental impacts more similar to those of the current operation or of the "Cease Operation and Maintenance" alternative would be likely.

6.10 Increasing the depth of channel maintained would tend to increase the size and number of barges and towboats that would utilize the river. With increases in river traffic, associated businesses would tend to increase their investments in river oriented facilities. There would be various environmental impacts, depending upon the manner in which the channel of greater depth was provided. Dredging to deeper depths would probably result in the handling of greater volumes of dredge spoil and depending upon the treatment and placement of the dredge spoil could result in an increased rate of the loss of aquatic habitat. Raising of pool levels would, on the other hand, increase the area of aquatic habitat at the expense of some of the existing terrestrial habitat. The general types of impacts of maintaining a deeper navigation channel would be comparable to those of the present method of operation, except that the magnitude would be changed, tending to be greater with a deeper channel.

6.11 Implementation of and subsequent operation and maintenance of either a channel of lesser or greater depths would require a major change of the primary objectives and would have major socioeconomic and environmental effects. There would be much controversy involved in making such a change.

MODIFICATIONS TO EXISTING OPERATION AND MAINTENANCE

6.12 Alternatives involving modifications to the existing method of operation and maintenance will be discussed in two basic settings:

a. Alternative measures. Each alternative measure will be discussed with regard to not only its relative social, economic, and environmental characteristics, but also the degree to which it is capable of reducing the adverse impacts of the existing operation and maintenance activities, and the extent to which it is dependent upon implementation of other measures to achieve its purposes.

b. Alternative plans. A combination of several alternative measures will be discussed as possible coordinated plans which could significantly reduce or eliminate the major adverse impacts of the existing operation and maintenance activities.

6.13 Pursuant to Section 122 of the River and Harbor and Flood Control Act of 1970, the guidelines for assessment of economic, social, and environmental effects of civil works projects were used in the evaluation of alternatives to insure that all significant adverse and beneficial effects of alternatives were fully considered.

ALTERNATIVE MEASURES

6.14 The alternative measures approach considers methods of alleviating adverse impacts of the existing operation and maintenance activities of the 9-foot channel either wholly or in part. The alternative measures are discussed with respect to the reasons for their consideration, what would be involved, the major effects and impacts resulting from their implementation, and the general applicability of the measure to the river system.

6.15 The alternative measures are discussed under the following major groupings:

a. Erosion and sediment control

b. Placement of dredged spoil

c. Dredge operations

d. Dam operations

e. Lock operations

f. Uses of dredged material

EROSION AND SEDIMENT CONTROL

6.16 Many of the major adverse impacts of the operation and maintenance of the 9-foot navigation channel project are related to sediment and sediment transport phenomena. Control of soil in-place before it becomes waterborne sediment, control of the deposition of sediment before or after it enters the river, and control of the material after it has been dredged from the river and placed in a disposal area are all major factors in the physical system of the river.

6.17 The alternative measures that deal with these factors will be discussed under the following headings:

a. Watershed land treatment

b. Sediment deposition control structures

c. Confined disposal areas

d. Shore protection of disposal areas

e. Revegetation of disposal areas

6.18 Watershed land treatment - Watershed land treatment, in its many and varied forms, has been considered as a possible means of alleviating sedimentation problems by reducing erosion and/or the subsequent movement of erosion-derived sediment. This might be expected to reduce the amount of maintenance dredging needed for the 9-foot navigation system, and, in turn, would reduce the adverse environmental, social, and ecological impacts associated with dredging. Watershed land treatment might also result in a reduction in natural sedimentation, particularly in biologically-sensitive backwater areas of the navigation pools.

6.19 Many aspects of watershed land treatment are addressed, including traditional conservation practices utilizing vegetation or mechanical practices, the use of structures to trap sediment or stabilize grades, and bank stabilization measures.

6.20 Since the 1930's, interest in conservation of agricultural and forest land has grown steadily. This has been aided by combined efforts of Federal, State, and local conservation organizations which have encouraged improved farming methods and more efficient land use to increase productivity and, at the same time, reduce soil loss. In addition, conversion of marginal, erodible cropland to grassland and woodland has been encouraged by soil bank programs over the last two decades.

6.21 The establishment of permanent vegetation such as grasses or trees is a very effective means of erosion control. The intermixing of permanent vegetation and cultivated crops is also effective, but to a lesser degree. Contouring and terracing are the principal mechanical practices used to reduce erosion. Strip cropping is a combination of vegetation and contouring. The vegetation effectively protects the soil from raindrop impact and slows any runoff that is produced. Contouring is used to reduce the effective slope, while terracing reduces steepness and slope length. In strip cropping, vegetation and litter in the strip filter out sediment as runoff passes through. Other farming methods having a significant effect on sediment yields include plowplant or minimum tillage to reduce soil disturbances and adequate fertilization to stimulate vegetal growth.

Soil Conservation Service representatives have indicated that an accelerated program of such land treatment measures could be effective in reducing the sediment yield of the study area by an estimated 15 to 30 percent.

6.22 Erosion and sediment from forest land can also be significantly reduced. Forest management practices include protection from forest fires, wildlife, livestock grazing, and overcutting; hydrologic stand improvement and tree planting; and proper location and protection of logging roads and trails.

6.23 Structural measures for controlling sediment yield range from small grade stabilization structures to large sedimentation basins. Grade stabilization structures are generally constructed in upland swales or gullies in order to keep sediment at or near its source. These structures slow runoff and decrease its sediment-transport capability by reducing the effective slope. In addition, a small amount of water retention may be provided to serve as a settling basin.

6.24 Sedimentation basins are formed by building dams across channels and/or floodplains just upstream of the area subject to sediment damage. These basins are designed to provide sufficient detention volume to reduce streamflow velocities and cause deposition of the incoming sediment load.

6.25 Bank erosion along the Mississippi River and its tributaries is particularly active during and immediately following floods, although it may also be caused by waves generated by wind or passing craft. Measures to improve bank stability and protect against erosive velocities include slope flattening, vegetation, riprap, and retaining walls.

6.26 If the watershed land treatment measures discussed could effect a substantial reduction in the quantity of suspended material and/or bedload reaching the Mississippi River, there could be several beneficial results. Primary attention would focus on their effect on operation and maintenance activities, particularly dredging. If there was a decrease in the amount of bedload reaching the main channel of the Mississippi River, maintenance dredging and its attendant adverse impacts would eventually be reduced. Conversely, a reduction in suspended load would not be expected to directly affect the need for dredging, but it could reduce the rate of natural sedimentation which is occurring in the biologically-sensitive backwater areas.

6.27 Both positive and negative effects and impacts would also occur in areas where watershed land treatment measures were adopted. For instance, the long-term productivity of the land would be enhanced by reducing soil losses. In addition, vegetation and water retention structures would provide additional wildlife habitat. However,

the cost of implementing some of these measures would be prohibitively high for individual landowners or watershed organizations and may be unjustifiably high when compared to the potential benefits. Also, there might be adverse social reaction toward efforts to control land use. This might be particularly true if farmers were urged to take land out of production during a period of apparent agricultural shortages.

6.28 Watershed land treatment has traditionally been aimed at retaining the agricultural productivity of the soil by reducing soil losses, particularly those resulting from sheet erosion. Therefore, traditional conservation practices affect primarily the amount of silt and clay reaching a watercourse, i.e., the suspended portion of the sediment load. Minor reductions in coarse bedload-type material may also occur if land treatment measures, such as revegetation or cessation of streambank grazing, result in stabilization of gully or riverbank edges. Similarly, grade stabilization structures are primarily intended to curtail soil losses, with possible incidental reductions in the field of coarse sediments. These measures would be particularly effective in reducing the quantity of material eroding from the upland loess mantle of the Driftless Area, which coincides roughly with the area inclosed by the 500 tons per year sediment yield isogram shown in Exhibit 63.

6.29 A decrease in maintenance dredging, which would require a significant reduction in the amount of bedload reaching the main channel of the Mississippi River, would probably not be noticeable as a result of implementing these measures. On the contrary, if these measures reduced sheet erosion without a compensating reduction in runoff, there might be a slight increase in bedload transport in gullies and streams due to the unsatisfied sediment-carrying capability of the flowing water.

6.30 Watershed land treatments can reduce peak flows in small watersheds. Measures such as contour plowing and increasing the acreage and density of vegetation tend to retard overland flow. This prolongs runoff duration and increased infiltration, both of which affect peak flow. The effectiveness in reducing peak flows from intense rainstorms or in large watersheds would be considerably less. Consequently, as the incoming suspended load was curtailed, the ability of the flow to pick up sediment from the streamed and streambanks might increase. Eventually, the increased erosion would reduce the stream gradient and/or enlarge its cross section, which would reduce velocities and, therefore, the movement of sediments. In the interim, the increased channel erosion would produce coarse material which could add to the amount of bedload sediments reaching the Mississippi River.

6.31 Measures such as sedimentation basins and bank stabilization would be more effective in eliminating or reducing the coarse fraction of the sediment load, either by capturing the bedload en route or by

holding it at its source by preventing streambank erosion. The most immediate effects on dredging requirements from these two measures would be achieved by implementing them on the tributaries near their confluence with the Mississippi River. This would directly decrease the amount of bedload reaching the navigation channel. This reduced sediment influx would release a portion of the Mississippi River's sediment-transport capability and promote scour which might further reduce shoaling in the navigation channel. Conversely, increased scour could result in undesirable bank erosion, possibly requiring costly protective works.

6.32 Adopting these or any other watershed land treatment measures in headwater areas would probably have little or no effect on dredging for many years, if ever. First, tributary dams controlling everything from small farm ponds to large multipurpose reservoirs already trap much of the bedload originating upstream of these structures. For instance, the source of most of the bedload materials contributed by the Chippewa River must be between the mouth of the river and Eau Claire, Wisconsin, since the dams at Eau Claire and Chippewa Falls, Wisconsin, probably trap a large portion of the coarse fraction of the sediment load. Watershed land treatment efforts further upstream would be largely wasted as far as their effectiveness in reducing dredging requirements.

6.33 Secondly, as with the case of reduced suspended load, if the influx of coarse sediments was reduced, the sediment-deficient flow would tend to erode the channel banks and bottom. The valleys of the major tributaries to the Mississippi River were carved and partially refilled with outwash sand during the Glacial Epoch, leaving a stockpile of readily available coarse sediments. Thus, for a considerable amount of time after these measures were instituted, a tributary would continue to deliver essentially the same amount of bedload material to the Mississippi River. Gradually, this amount of bedload would diminish as the stream adjusted its slope and cross section to the reduced influx of coarse material. The effects of these measures would become apparent in a reduced need for dredging. For example, based on the pool-by-pool sediment balance computations discussed in the Sedimentation subsection of the Environmental Setting, it was estimated that preventing erosion of the sand and gravel terraces along the lower Chippewa River might eventually reduce dredging in pools 4 (below Lake Pepin), 5, and 5A, by an average of about 35 percent.

6.34 The period of time necessary for watershed land treatment measures to yield tangible results in the form of reduced dredging cannot be determined with the information on sedimentation which is presently available. Exhibits 75 and 76 and the accompanying discussion in the Sedimentation subsection of the Environmental Setting might suggest a possible time frame in which effects were noticed which may have resulted from bank stabilization and land treatment measures instituted in the last 40 years. As pointed out in the referenced discussion, other factors may also have been responsible for the effects on dredging requirements.

6.35 In addition to the uncertain time element involved with watershed land treatment, other factors would have to be considered before this measure received serious consideration. For instance, the social impact of trying to implement a comprehensive regional land treatment program far more intensive than anything tried to date on this scale would have to be carefully weighed. The Soil Conservation Service has noted recent evidence of declining interest in conventional conservation practices such as contour plowing. Apparently, there is more concern with achieving a high degree of farming efficiency by means of straight furrows. Also, trying to institute more watershed land treatment measures in an emerging era of food shortages, which encourages cultivation of every acre possible, would probably be difficult.

6.36 The savings in terms of money, manpower, fossil fuels, and so on that might result from a reduction in dredging brought about by a comprehensive watershed land treatment program might not balance the expenditure that such a program would entail. More detailed studies might be able to weigh other quantifiable and unquantifiable benefits of reduced erosion and sedimentation, such as savings in agricultural productivity; reduced damage to roads, buildings, or other works located along eroding streambanks; improvements in water quality; and reduced rate of degradation of biologically-sensitive sediment deposition sites.

6.37 Sediment deposition control structures - The operation and maintenance of the 9-foot navigation channel and other river improvements such as urban, commercial, and recreational developments, and wildlife refuge management each experience major problems associated with river sedimentation processes. Each use usually prefers to have the sedimentation process of the river within the floodplain handled or treated in a different manner, although most interests would prefer to have erosion problems treated at the source to prevent sediment from entering the river. Structures to control the manner and location of sediment deposition within the Mississippi River and the lower portions of its tributaries could be considered as a means of reducing the adverse impacts associated with the operation and maintenance of the 9-foot navigation channel project.

6.38 The use of structures such as wing dams, closing dams, sediment barriers, and other similar structures could be used to control sediment deposition by modifying the flow pattern and/or the velocity of flow in the river. The wing dams and closing dams that were constructed in conjunction with earlier shallow depth navigation channels used the concept of restricting the majority of river flow into the narrow section of main channel which increased the low flow stages and the flow velocity in the main channel. The sediment-carrying capacity and characteristics of the river were changed slightly, with increased sediment-carrying capacity in the main channel and decreased capacity in the channel border, off-channel, and backwater areas.

6.39 Sediment barriers, such as either a submerged sill or a much larger dam which would impound water, could act as effective barriers to bedload materials carried by the tributary streams into the Mississippi River proper. Some of the finer suspended sediments might settle out in a larger impoundment. Proper location of wing dams, closing dams, and sediment barriers could be used to reduce the amount of sediment entering the river or change the exact location of deposition within the main channel. The size and shape of the structures would vary depending on their location and period of design effectiveness; however, the general configuration and shape of the wing dams and closing dams would be similar to those existing within the river now. The wing dams would probably flank the main channel, rising above the water to provide maximum flow in the constricted area but not so high as to restrict flood flows. The closing dams would probably be placed across the feeder channels to the backwater areas to keep the water in the main channel. A sediment barrier located at the mouth of a tributary stream could traverse the entire width of the stream and, although not appreciably affecting the flow, could interrupt the sediment load, especially the bedload.

6.40 The major effects and impacts of using sediment deposition control structures include impacts caused by construction and those caused by the resulting change of sediment transport and flow patterns in the river. Reductions in the amount of sediment reaching and accumulating in shoaling locations that are being dredged would tend to reduce the extent of the adverse impacts associated with the current operation and maintenance activities. The new locations of sediment deposition caused by installation of sediment deposition control structures would create dredging needs in new areas. The impacts of dredging in these new locations would cause beneficial and/or adverse effects, depending on the specific circumstances in each location. If the new dredging locations facilitated placement of the dredged material in areas which offered greater potential for beneficial uses of the dredged materials, the total adverse impacts of placement might be reduced. Dredging costs might be either increased or decreased, depending on specific circumstances. Where the new dredging locations would allow improved efficiencies of dredging operations there would probably be cost reductions; however, possible increases in the quantities of material to be dredged, especially on the tributary sediment barriers might offset any potential cost reductions. The net effects and impacts of these structures would have to consider all changes, including where dredging needs would be reduced, where dredging needs would be increased, the construction area, and other potentially impacted areas. In spite of the wing dams and closing dams present in each pool, shoaling currently occurs in many locations along the main channel and requires dredging. These wing dams and closing dams were designed and built for conditions prior to the 9-foot channel project, however, and are not fully effective with the 9-foot channel project. The river has an irregular bottom profile with deep holes and shoal

areas. The natural tendency of the river is to maintain this relationship. The more control and restrictions that are placed on the river, the less natural variations are found. To maintain a uniform bottom profile and eliminate the dredging requirements, an almost completely confined and uniform channel would have to be attained.

6.41 Confinement and control needed to effectively attain a very low amount of shoaling would almost completely isolate backwater and off-channel areas during low flows or at locations where navigation channel depths and the sediment-carrying capacity of the river become critical. This isolation of flow from the backwater areas would be especially critical at the larger channel inlets, both in terms of the effects on the sediment deposition in the main channel and the adverse ecological impacts in the backwater areas caused by lack of flow.

6.42 Trapping bedload sediment from tributary streams could greatly reduce the amount of coarse material reaching the Mississippi River. The natural tendency of the river to transport bedload sediments would continue to promote shoaling within the navigation channel. Some reduction in the amount of material needing to be dredged would probably occur, although the actual effect on maintenance dredging is not known.

6.43 The sediment trapped by the barrier would have to be removed periodically to allow the barrier to continue to function effectively. The added costs of constructing the barrier and removing the sediment trapped may exceed the cost savings achieved by the reduction in dredging. In addition, the river would tend to pick up sediment downstream from a sediment barrier by scouring channel banks and bottom, which could result in undesirable erosion and probably require riprap bank protection in certain areas.

6.44 The areas that offer the greatest potential for reduction of adverse impacts by use of sediment deposition control structures would probably be:

a. Use of a sediment barrier at the mouth of those tributary streams which carry a significant quantity of bedload into the Mississippi River navigation channel, such as the Chippewa River.

b. Use of wing dams in localized reaches of the channel where the shoaling area could be moved from a remote channel location to one which would provide disposal of the dredged spoil on sites facilitating more beneficial uses of the material.

6.45 Due to the complex nature of sediment transport phenomena of the river, any areas where potential reduction of adverse impacts might be considered by using sediment deposition control structures, detailed investigations would be required to determine the actual effects of implementing such a measure. Any net impacts of this type of action would have to be determined on a case-by-case basis.

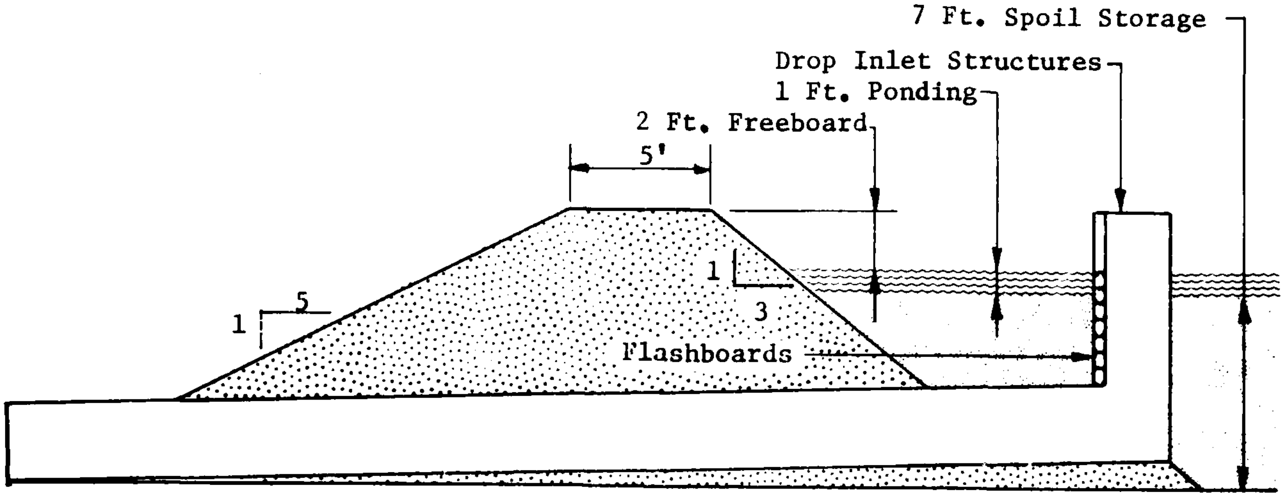
6.46 Confined disposal areas - Unconfined disposal of dredge spoil has several undesirable aspects, including the need for large disposal areas, the loss of fine-grained materials into surrounding waters, and movement of spoil out of the immediate disposal area.

6.47 Confined disposal is being considered because of its potential for minimizing or preventing many of the undesirable consequences of unconfined disposal. The area required for a confined disposal facility could be less than if disposal were made under unconfined conditions. Also, a confined facility can be designed to provide some retention time for the dredged slurry. This will permit fine materials to settle out and be retained on-site rather than being discharged into the waters surrounding the disposal site.

6.48 A confined disposal facility could be constructed using steel cellular sheet piling, tied back steel sheet pile walls, gabion walls, or sand dikes. Cost estimates indicate that sheet steel or gabion structures would be several times more expensive than sand dikes. In addition, a sand dike constructed from locally available materials is probably aesthetically preferable to the unnatural appearance of sheet pile or gabion walls. Consequently, although steel sheet pile or gabions might be better suited in certain instances, sand dikes would probably be given prime consideration as the general method of constructing confined disposal facilities.

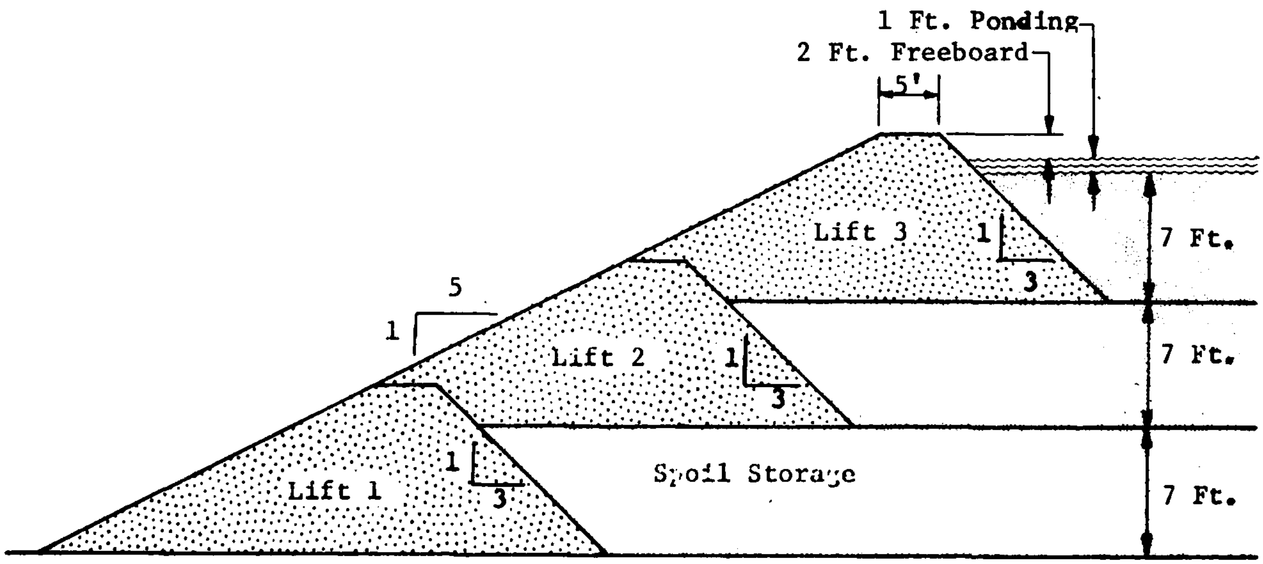
6.49 Material for sand dikes is available at existing disposal sites. Dikes could be constructed using bulldozers or scrapers to reshape spoil material into dikes. Dike construction in areas not previously used for disposal would probably have to be preceded by hydraulic pumping of spoil onto the site to provide a surcharge to promote consolidation of underlying silt, clay, and/or organic materials. After the foundation had been stabilized, dike construction could proceed as usual. The placement of the hydraulic fill along the levee alignment could be facilitated by use of "bleeder" pipes in the discharge line which allows material to drop out of a pipe section through slits on its bottom side. These sections could be aligned above the desired levee alignment and then the material would fall out rather evenly over the length of discharge pipe.

6.50 A typical dike section is shown in the following figure.



Typical Sand Dike Cross Section for Confinement of Dredged Spoil

6.51 For stability, a maximum height of 10 feet is assumed, which will provide 2 feet of freeboard, 1 foot of ponding to provide a minimum retention time of 2 hours for fine particles to settle out of the dredged slurry, and 7 feet for containment of dredge spoil. Since dredge spoil is predominantly sand which does not "fluff" significantly when excavated, the volume provided for confined disposal at a particular site was assumed to be equal to projected dredging requirements. To control ponding elevations, drop inlet structures with adjustable flashboards could be installed. If the initial dike section and confined area would be unable to handle the quantity of spoil anticipated during the life of the facility, subsequent dike raises as shown in the following figure could be made as the capacity of the disposal area was reached. Each dike raise would require either extensions for the old drop inlet structure or the installation of new structures.



Typical Cross Section of Sand Dike Raises

6.52 If the disposal site were planned for several years of use, the outer slopes of the dikes could be vegetated and/or riprapped immediately after construction for aesthetics, stabilization, and fish and wildlife habitat. When the facility had been fully utilized, the top and interior could be rough-graded as needed and vegetated. Unless the dike slopes were vegetated or otherwise stabilized, they would tend to be more subject to erosion than unconfined disposal sites, due primarily to the steeper side slopes.

6.53 The major effects and impacts of confinement of disposal areas involve a more definite control over where the spoil is actually placed. Dredge spoil taken from the Mississippi River within the St. Paul District generally assumes a slope of about 1V on 10H (1 vertical on 10 horizontal) when hydraulically pumped into an unconfined area. These flat slopes result in relatively large areas of terrestrial and aquatic habitat being covered by the spoil. Finer materials in the pumped slurry tend to wash down the slope of the spoil pile and into surrounding waters. These fine particles are a major source of turbidity during a dredging operation and are carried beyond the immediate boundaries of the disposal site, effectively extending the area affected by the dredging operation. Use of a confined disposal area could reduce the amount of fine material being carried into backwater areas by allowing them to settle out within the confined area. Reduction of the amount of fine material entering backwater and other aquatic habitat areas would reduce adverse impacts on the aquatic ecosystems, especially to turbidity-sensitive species.

6.54 Use of steeper side slopes (1V on 5H) with sand dikes would tend to reduce the area occupied by a disposal site; however, construction and ponding requirements would tend to increase the area needed. Although the area required for confined disposal would generally be less than that for unconfined disposal, when containment of small volumes of dredge spoil is being considered, a confined site might actually be larger than an unconfined site (see Exhibit 189). In either case, the area affected by fine materials would be reduced.

6.55 Use of containment facilities would require dedication of the entire facility to dredge spoil deposition for the design period. Due to the economics of size, a larger facility designed for a longer period of use with several staged levee raises being incorporated to keep the total area affected to a minimum would usually be desirable. Because of the ponding of water behind the levee, the chance of levee failure would be present. Sudden failure of the levee could cause adverse impacts on the surrounding areas.

6.56 The costs for construction of sand levees only (riprap, etc., not included) for confinement of dredged spoil along the Mississippi River within the St. Paul District would be relatively inexpensive compared with other types of levee and containment facility construction.

The low degree of potential hazard from a failure is a principal reason for this, along with the readily available source of material for construction. Cost estimates for levee construction would vary from site to site depending on specific conditions; however, the cost figures shown in Exhibit 189 give some indication of what construction costs might be. Areas in which containment facilities are considered most desirable are those where a large percentage of the solids being dredged are very fine and do not settle out of suspension near the disposal site.

6.57 Confined disposal would result in increased operation and maintenance costs for the 9-foot navigation system. Based on a cost per unit volume of storage, containment facilities for large quantities of spoil would involve rather modest cost increases for disposal site preparation. However, use of larger, but fewer disposal sites would probably require an increase in dredge plant capability to place spoil at greater distances from the dredge cut. This could add significantly to unit costs. Conversely, use of smaller but more numerous disposal sites might avoid the need for increased plant capability; however, the dike construction costs at these smaller sites could increase unit costs significantly.

6.58 Use of only a 7-foot depth of dredge spoil placement within the confined area might incur extra costs for increased handling of shore pipe at the disposal point. This would be most significant in confined areas which would be designed for a single disposal event. In large confined areas, the dredged spoil placement would be planned so that this would not cause a problem.

6.59 Federal regulations require confinement of dredged spoil when determined to be a pollutant (ref. PL 91-611, Section 123). However, except in the Great Lakes, the Corps of Engineers does not have a general authority to provide containment facilities for polluted dredge spoil. Corps of Engineers policy regarding open water disposal of dredged material determined to be polluted by Environmental Protection Agency criteria is stated in EC 1165-2-116* as follows:

> "On those projects where open water disposal is the current practice, this practice shall continue, unless local interests provide suitable alternate confined areas at no cost to the Government. Where no authority is available to the Corps of Engineers to provide retention facilities and local interests do not have the capability or means of providing such facilities and the state or local authorities disapprove of past disposal procedures, the Governor should be advised that the alternative is to suspend dredging operations and the effects thereof, and his view sought on action to be taken."

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*Office, Chief of Engineers, Department of the Army, CE, "Disposal of Dredged Materials", Engineering Circular 1165-2-116, August 1972, Washington, D.C.

6.60 To date, the Environmental Protection Agency has not classified any material dredged within the St. Paul District as being polluted, nor have any containment facilities been utilized in conjunction with operation and maintenance of the 9-foot channel project within this District. Any provision of containment facilities for disposal of dredged spoil would require proper justification.

6.61 Shore protection of disposal areas - Although the loss of material from spoil disposal areas due to shoreline erosion has not been quantified, shore protection could be provided at disposal sites where erosion is known to be causing unacceptable secondary movement of dredge spoil. Material eroded by wave action or propellor wash will tend to move directly toward deeper water. This material may wash back into the dredge cut or into biologically-sensitive backwater areas. High water flows tend to move eroded spoil in the direction of flow of the prevailing current, generally downstream. This material may be contributing to the partial closure of guts or sloughs feeding fresh water into backwater areas.

6.62 Riprap protection has already been provided for much of the riverbank along the Mississippi River, with that along railroad embankments being quite extensive. Riprap placed along the channel in conjunction with the wing dams constructed prior to the 9-foot channel system is now mostly submerged. However, it still provides erosion protection below the waterline, helping to stabilize not only the landforms along the river, but also the dredge spoil placed on top of these landforms.

6.63 Consideration may be given to improving this existing bank protection if necessary and providing new protection at disposal sites in areas not already protected. This protection could be provided by riprap, steel sheet pile, gabions, or other structural means. Poor foundation conditions as well as cost and aesthetic considerations make riprap the most practicable and economical alternative. In addition, riprap would improve the aquatic habitat by providing an excellent substrate for the growth of aquatic invertebrates, thereby providing food for fish as well as additional habitat.

6.64 The riprap would consist of a blanket of heavy rock underlain by filter cloth or a layer of filter material to prevent fine materials from washing from between the larger stones. Generally, the riprap would be provided from near the bottom of the channel to a point several feet above the project pool level. The cost of this protection is estimated to be about $100 per linear foot, although costs may vary considerably at different locations. Because of its high cost, bank protection would generally not be warranted except at especially critical locations, where a unique or valuable area would need to be saved from adverse impacts caused by erosion of the dredged spoil. Actual locations where this might be justified were not determined; individual case-by-case studies would have to be conducted to determine where and if this measure might be applicable.

6.65 Revegetation of disposal areas - Stabilization of spoil sites with vegetation minimizes the return of dredged material to the river system and assures the potential use of the material for recreation and terrestrial wildlife. Minimizing secondary movements of the spoil may also reduce the following: frequency and amount of future dredging, blockage of backwater channels, shoaling in undesirable locations, water turbidity downstream of the disposal site, rate of sedimentation in backwaters and side channel areas, coverage of benthic invertebrates and plant life, and additional coverage of terrestrial vegetation as steeper slopes level out and become more gradual.

6.66 Variables affecting an individual plant's potential for survival in a dredge spoil area include the tolerance and/or depth to which root systems can be covered and the height of the plant species at the time of coverage. For example, cottonwood (Populus deltoides) can tolerate a great deal of root system coverage while silver maple (Acer saccharinum), basswood (Tilia americana), or swamp white oak (Quercus bicolor) cannot. Total coverage of young trees, brush, forbs, and grasses undoubtedly results in death.

6.67 Plant succession (the replacement of one community by another) on dredged spoil material appears to be a combination of both primary and secondary succession. Elevated portions of dredged spoil piles containing no prior vegetative growth would succeed through the slowly developing series of primary successional stages if left undisturbed. Edges of spoil piles are more likely to be representative of secondary successional trends where changes of specific plant groups are relatively more rapid or even passed over. For example, development of woody vegetative growth could precede the establishment of grasses or herbaceous plants.

6.68 Natural plant succession on sandy dredge spoil sites is generally slow due to the lack of nutrients, moisture, and stability. Among the Lake Michigan sand dunes it has been estimated that it may take 1,000 years to develop a climax association of an upland forest type. Climax is the final, stable community in a succession which is able to reproduce itself indefinitely under existing conditions. In this case natural vegetative establishment proceeds along primary successional trends where physical conditions are altered by successive plant associations. For example, pioneering plant species gradually stabilize the sand and build up a sufficient amount of organic material which a new plant association requires in order to establish itself. This stage would in turn modify the soil further to permit different plants to become established. Among dredged spoil materials immediate vegetative growth or establishment does take place under certain conditions. For example, two distinct types of vegetative growth that take place almost immediately are seed or spore germination along moist edges and vegetative reproduction due to stolons or rhizomes from previously established plants.

6.69 Availability and constancy of moisture is apparently important in the germination of disseminated seeds. Edges of dredge spoil sites in contact with relatively calm water demonstrate a prolific growth of cottonwood and willow (Salix spp.) sprouts. Herbaceous plants such as smartweeds (Polygonum spp.) and sedges (Carex spp.) are also common. The area of sprouting is, however, limited in elevation to about 3 feet as the constant moisture factor is probably a product of water made available by capillary action.

6.70 Vegetative growth due to the spread of stolons or rhizomes is apparently common. Established species which are near the edge of a spoil pile or only partially buried may send up new sprouts. Cottonwood, willows, some types of grasses, and vines could invade a newly deposited spoil pile in this manner. This is generally a slow process, however, and the importance of this aspect has not been thoroughly investigated.

6.71 Effects of evaporation and normal drainage produce a moisture-free area on the surface above the moist, near-water zone. Therefore, a moisture-free area exists over much of the spoil area which inhibits the establishment of vegetation. Moisture is available 6 - 12 inches below this dry surface layer, probably due to the specific retention of the sandy dredged material. However, the moisture is beyond the reach of germinating seeds. The moisture-free area probably increases in depth during dry periods, but is reduced again following precipitation.

6.72 Willow and cottonwood are important colonizers of newly exposed spoil. Initial seed dispersal of these prolific species is accomplished as a result of wind action transporting the seeds either directly to the site or indirectly when seeds settle on the water and float to the site. Seed dispersal generally occurs after spring high water. Willow requires continually moist soil and is more likely to be established near the water. Cottonwood is relatively drought resistant and once established is more likely to be present further away from the water.

6.73 Considerations involving the establishment of vegetative cover include the following:

a. Chemical nutrients - application of nitrogen, phosphorous, etc., to compensate for the lack of macro and micro nutrients in the sandy dredged material. Commercial fertilizers are available with variable nutrient proportions. Slow-release forms of nitrogen are desirable due to nitrogen's high degree of water solubility and subsequent loss through leaching.

b. Planting - the optimum mixture of various seeds and their application is presently unknown and research in this area is obviously needed. Application of seeds by the use of a Hydro-Seeder

would be recommended for the following seed mixture: field brome grass 8 lb/acre; sand drop seed 3 lb/acre; sand love grass 3 lb/acre; hairy vetch 15 lb/acre; switch grass 3 lb/acre. This mixture would apparently provide a sufficient mixture of xeric grasses and legumes to hold the soil temporarily and provide for build up of organic materials. Seeding should occur in the fall. Additional plant species which might prove suitable are included in Exhibit 190. American beach grass is apparently well suited for the area and clones might be planted by hand or with a mechanical planter. Planting intervals should be 4 feet to allow for rhizome development. Stem or root sections of cottonwood or willow can be placed at various locations on the spoil piles. Location should be determined by the availability of constant moisture for rapid root growth and continued survival. In specific instances it might be desirable to plant larger trees. This would, of course, depend upon the severity of need and a consideration of the extra expenses involved.

c. Organic deposition - application of a layer of organic material over the surface of the spoil pile could provide a substrate for seed germination and rooting. Considerations of economics would play a large part in determining the thickness and the relative effectiveness of increasing the depth. It is recommended that the depth be between 1 and 4 inches. Mechanical spreading or mixing of the materials should also be considered.

Bottom materials from backwater channels, lakes, or marshes might be utilized if their use is considered beneficial. Waste, from municipalities near or bordering the river and which has received primary or secondary treatment, could be used to provide both an organic base and a nutrient supply. The sludge could be in effect odorless or sterilized and not obnoxious or constitute a health hazard. Problems of total containment and public sentiments in terms of pollution would have to be seriously considered. Organic soils could be transported in from surrounding agricultural areas. The soil itself might contain an adequate supply of buried seeds, and additional seeding or planting operations might then be reduced in quantity. Cost estimates would have to take into account the nature of the material, transportation distance, method of application, etc.

Netting materials, wood fiber materials, or hay might be utilized to encourage seedling establishment and moisture retention and to prevent wind erosion. Hay or straw mulch may be applied with a mulch blower at a recommended 3,000 lbs. per acre. Anchoring could be accomplished by tacking down the mulch material with an asphalt emulsion of infra-mulching with a notched disk. Another mulching alternative would be the use of a biodegradable plastic mulch net blanket.

d. Timing - the period of establishing of cuttings, planting of seeds, or transplanting is critical to vegetative establishment. Duplication of natural rhythms such as spring dispersal of willow and cottonwood would appear important. Dormant willow wands could probably be refrigerated and placed in dredged spoil areas when appropriate. Warm season grasses (native) should be planted in the spring, especially on newer spoil sites, to alleviate that year's erosion problems. During the summer months, high temperatures can be expected to occur at or near the surface of the dredged material. Excessive temperatures would probably inhibit or destroy germinating seeds.

e. Origin of seed stock - considerations pertaining to the selection of potential planting materials should be influenced by the origin of parent stock. It is recommended that planting materials come from sources not exceeding 300 - 400 miles in a north-south direction and 500 miles in an east-west direction. Physiological acclimation affects localized populations of a plant species (ecotypes) with a wide geographical distribution. Therefore, utilization of a genetic strain which is preadapted to environmental parameters similar to the potential planting sites is more likely to result in success.

f. Adaptability - all plant species respond best to an optimum range of environmental parameters. Small excesses or deficiencies outside of these parameters may result in minor responses, but large variations could result in death or inhibit reproduction. Therefore, selection of plant materials for vegetative establishment should take into account the physical extremes encountered on dredged spoil materials.

g. Reshaping dredged piles - leveling off the top, reducing the slope, elongating or widening the pile, or other means of mechanically altering the shape of dredge sites.

h. Shore protection - riprap, log booms, etc., to encourage initial stabilization of the dredged material. Submerged or emergent aquatic vegetation could be encountered along the waterlines of spoil piles. Wave action might then be reduced to some degree which would in turn increase the potential for vegetative establishment near the water's edge.

i. Naturally protected sites - placement of dredged material further from the shore in the larger wooded islands or mainland. Deposition may also be confined to the lower end of main channel islands or on the inside of a river bend.

j. Willow staking - concentric rings of live willow saplings could be staked around the point where spoil is being discharged. The saplings would decrease the velocity of the discharge water and thus increase the grade of the spoil pile. Thus, the pile would not extend outward as far. The partially buried willows would take root and prepare the area for subsequent spoilings or vegetative establishment.

6.74 Impacts associated with vegetative establishment on dredged spoil piles include the following:

a. Loss of sand areas - establishment of vegetation on dredged spoil deposits could be detrimental to nesting turtles and possibly some shore birds. Loss of potential recreation sites in terms of camping or picnicking could also occur.

b. Wildlife habitat - vegetated areas would provide nesting habitat for ground nesting birds such as waterfowl as well as other ground and tree nesting birds. Avoidance of vegetation in strips is important. Narrow strips at or near the water's edge would probably increase nest predation. Consideration should also be given tc plants which would serve more than one purpose. Establishment of dogwoods (Cornus spp.), raspberry (Rubus spp.), or elder (Sambucus spp.) would tend to stabilize the dredged material and provide fruit for songbirds, waterfowl, and grouse as well as possible browse for deer and rabbits. Leguminous plantings could tend to act as a stabilizer, add nitrogen in the spoil and provide food and cover for various wildlife species.

c. Aesthetic improvement - the unnatural appearance of non-vegetated, linear, continuous spoil deposits bordering the navigation channel could be eliminated.

d. Reduction of secondary spoil movements - erosion as a result of wind or water movement eventually returns a portion of the dredged material to the river; however, the actual amount being returned is not known. Subsequent uncontrolled deposition usually occurs downstream from the pile. Therefore, production of sand bars which in some instances could hinder or menace both recreational and commercial watercraft could be reduced. Backwater channel blocking and subsequent reduction or elimination of water movement with increased rates of eutrophication in backwater marshes and lakes could also be reduced as well as loss of navigability or access to backwater areas by recreation users. A reduction in the rate of sedimentation in the main channel adjacent to or near the dredging site could be possible. The frequency and/or amount of future dredging might therefore be reduced. Beds of aquatic vegetation and clams near spoil sites would probably have a longer period in which to establish and maintain themselves if secondary movements were reduced or eliminated. A reduction or elimination of eroding spoil deposits in shallow, shore areas would also reduce local turbidity, thus increasing light penetration and promote growth of aquatic vegetation.

e. Utilization of plant materials by recreation users - vegetated areas at various stages in a plant successional series would present a variety of useful commodities. Relatively young areas might offer a variety of edible berries. Medium-aged areas might provide berries, mushrooms, and campfire wood. With favorable considerations in market value, a mature stand of timber could become an economic asset.

6.75 Under the present method of operation and maintenance, there is no established program to encourage vegetative growth on dredged spoil sites. Encouragement of vegetative growth would best be implemented at the time of dredge spoil deposition or immediately afterward. Establishment of vegetation on older dredge spoil sites is also possible. Recurrent costs would be limited to the possible addition of fertilizer to the site within 2 - 3 years after planting and the possible application of water during drought conditions when the vegetative cover is just beginning to establish itself. It may be necessary to restrict recreational utilization of newly vegetated areas until establishment is assured.

6.76 Establishment of vegetation could be a technique applied to nearly all alternative plans of dredge spoil treatment in which stabilization is desired. Specific alternatives include selective placement, central disposal, and remote disposal. An exception would be the removal of materials from the floodplain. The existence or encouragement of vegetative cover complements nearly all potential uses of the area such as wildlife habitat development, recreational development, etc. Many detrimental aspects of dredged spoil placement could be alleviated or eliminated by adequate coverage of vegetation.

6.77 Costs for revegetation vary with the type of seed application. Hydro-seeding includes an application of seed, fertilizer, and mulch at the same time. The cost of application by hydro-seeding would be approximately $775 per acre. Planting of seeds to a required depth is somewhat haphazard with this procedure. The Nesbit drill sets seed at an optimum depth. An Imco mulch tiller could be used following sowing to secure the straw mulch. Costs of application by Nesbit drill and a straw mulch are estimated at approximately $730 per acre. Willow and/or cottonwood staking followed by hand sowing and raking could be advantageous on smaller, isolated areas and would cost approximately $400 per acre.

6.78 The length of time elapsing between the deposition of dredged materials and implementation of revegetation depends on the type of material dredged and the methods employed in revegetation. Silt and clay materials may require months to settle and dry before even small-sized machinery can be used. Sandy materials could be worked much sooner. Willow and cottonwood cuttings could be planted before depositing spoil materials or anytime afterward. The hydro-seeder could be used immediately after spoil deposition and before consolidation of the spoil materials. This could be feasible in instances when most or all areas of the spoil pile are within 150 feet of the water's edge.

6.79 Revegetation by itself is not a long-term solution in stabilizing and enhancing maximum use of dredged spoil materials. However, it may be considered an effective short-term solution if combined with other measures.

PLACEMENT OF DREDGED SPOIL

6.80 The placement of dredged spoil within the floodplain can have varying environmental impacts depending on the location of placement, the height to which it is piled, and the number of locations in which it is placed. Although the basic adverse environmental impacts of loss of aquatic and terrestrial habitat would continue with placement of dredged material in floodplain areas, the degree of impact could vary greatly. Both the quantity and quality of habitat which potentially could be directly or indirectly affected are related to dredged material placement policies. The greater the flexibility of placement of the dredged material, the greater the potential for reduction of adverse impacts on the river ecosystems. To achieve more flexibility in the placement of dredged material to reduce the adverse impacts on the ecosystems, additional capacity would have to be added to the DREDGE THOMPSON to allow greater distances of placement. The current limits of the DREDGE THOMPSON present a definite restriction as to the minimum adverse impacts on the ecosystems imposed by operation and maintenance dredging activities.

6.81 Generally, the greater the number of disposal sites used, the greater the area that is directly affected by the dredged material. Greater heights of dredged material placement usually affect a smaller total area. Both of these techniques could be used to reduce the extent of adverse impacts; however, the greatest potential for reduction of adverse impacts through placement techniques lies primarily in the specific location of spoil placement. Placement in areas which cut off flow channels to backwater areas, either directly or indirectly, or in areas which provide or are particularly key elements to the ecosystem would result in adverse impacts, such as effects on fish spawning areas from turbidity, etc. to areas much greater in extent than the localized area of placement. Greater placement flexibility would permit more opportunities to avoid such potential adverse impacts.

6.82 Complete coordination by all affected interests, including the Corps of Engineers, U.S. Bureau of Sport Fisheries and Wildlife, and the States of Minnesota, Wisconsin, and Iowa, is of primary importance in selecting areas for dredged material disposal. Wise selection of disposal areas needs to be based on an interdisciplinary approach which would provide a cross section of expertise in the various fields affected. Coordination meetings in the past have met with varying degrees of success, with some participants taking constructive attitudes and others taking obstructive attitudes. Constructive roles by all participants is necessary to assure the best approach for placement of dredged material. With increased coordination between affected interests, a better understanding of the dredging operations, capabilities, requirements, and impacts should be obtained. Better understanding between all interests usually results in a more cooperative attitude and approach for working out basic problems. The misunderstanding of the dredging situation and its effects on the river system

are usually compounded by failure of any given party to recognize or understand all sides or at least certain important aspects of the situation. Fewer opposing viewpoints and basic cooperative attitudes would help to develop the entire river system for the maximum overall public benefit.

6.83 Planned disposal of dredged material in a designated area might provide a technique to alleviate some adverse environmental impacts. Such a disposal technique might mean starting in one portion of the disposal area and building it up to the finished dimensions and then proceeding to fill the rest of the area, leaving the maximum amount of finished area after each disposal. This technique could be used to provide a good working base for developing the disposal area into other uses such as a recreational area or wildlife habitat.

6.84 Another technique to alleviate adverse impacts might consist of controlling the return water from dredging by careful placement of the discharge pipe and use of flashboards, sand dikes, and/or ditching. The dredging water with its high silt load could be diverted away from areas with high environmental value. In some cases this would provide a short term reprieve for areas that would probably eventually be affected by dredged spoil. Timing of dredging operations so as not to coincide with sensitive biological functions might reduce some adverse impacts. This would require coordination with other agencies and interests. Monitoring the water quality of the area around the dredge disposal sites to determine more precisely the specific impacts of spoil disposal in any given area might also give some guidance in selecting future disposal sites. Monitoring the actual primary and secondary movements of the dredge spoil would also assist in the selection of new disposal sites.

6.85 Dredged material placement alternatives are all basically related to how far, where, and why the material is to be moved. Two basic placement alternatives consist of placement on floodplain lands or removal from the floodplain. Under each of these basic placement alternatives, there are many possible approaches to selection and description of the final material placement site. To facilitate an understanding of the basic principles involved, the following alternatives will be discussed:

a. Selective placement in the floodplain

b. Remote disposal in the floodplain

c. Central disposal in the floodplain

d. Removal from the floodplain

6.86 These placement alternatives were selected based on alleviation of adverse environmental impacts which are caused by limitations of placement capability. Alleviation of certain adverse impacts on the ecosystems by changing the placement locations would cause added costs and as such an adverse economic impact of maintenance and operation of the 9-foot channel project.

6.87 The basic concepts of adopting a long-term planned approach to dredged material disposal activities and affecting as small an area as practicable, should be incorporated into the selection of any placement site. This would require complete coordination of all interests and also a basic concurrence with the adopted decisions. These concepts will be assumed to be in effect for the following discussions of the placement alternatives.

6.88 Selective placement - Selective placement would consist of disposal of the spoil material from localized reaches of the river in floodplain areas near the dredge cut where it would cause the least amount of adverse impact. These areas would be selected by agreement of all interests and in reasonable and practically located areas, and if possible in areas that could be developed for other beneficial uses. This alternative placement measure would be significantly different from existing practices in that the selection of disposal areas would involve expanded plant capability to get the material away from the most sensitive areas of adverse impact. However, any expanded plant needs would be limited to those associated with achieving the basic purpose of moving the material away from the area currently being adversely impacted and would probably be limited to a maximum of about 1 1/2 to 2 miles of placement capability. The unit cost of handling the material would increase because of the extra plant capability required. Such cost increases could be significant compared to the present costs of dredging. The costs could seem quite reasonable, however, when compared to the costs of other methods of handling the dredged material.

6.89 By reducing the number of disposal sites and by increasing the height of placement, the area subject to the direct effects of having sandy dredged spoil placed thereon would be reduced. Indirect adverse effects of dredged spoil movement into backwaters and backwater channel areas could be reduced by placing the material away from especially sensitive areas.

6.90 Selective placement of material could provide the potential for more compatible uses of the sand as a part of the productive and valuable river environment. The effect of linear placement of spoil adjacent to the channel would be somewhat alleviated by use of fewer disposal areas. Placement of spoil to form islands in large open backwater areas could have beneficial effects on submergent aquatic vegetation by reducing wave actions.

6.91 Effective reduction of adverse impacts of current dredged material placement policies by implementing the selective placement approach would depend upon availability of less ecologically sensitive areas for disposal, the availability of the required dredge plant to move the material, the ability to use the material for other beneficial uses, and the ability of the interests involved in coordination to reach agreements.

6.92 Remote disposal - This measure would be similar to selective placement except disposal areas could be planned to serve for a longer period of time and be located in fewer areas of the pool, usually limited to two or three areas per pool somewhat centrally located near certain frequently dredged reaches. Placement of material in these remote areas would probably require a dredge plant placement capability of from 3 to 5 miles. These areas could be located in the floodplain at some distance from the main channel in an attempt to minimize any adverse impacts associated with proximity to the navigation channel. As with the procedures described under selective placement, coordination could be utilized to select suitable areas for disposal.

6.93 The major effects and impacts of using remote disposal areas are basically similar to those of selective placement, except that the unit costs of handling the material would increase significantly because of the large amount of dredge plant placement capability required. The extra dredge plant requirements would necessitate a much more complex dredging operation than currently used. In addition to requiring additional plant with floating line, many remote disposal areas could be located at a distance from the main channel and require construction of special facilities across the backwater areas to get the material to the final disposal site. This might include dredging of access channels for the floating pipeline and booster pumps, or the installation of a permanent shorepipe facility that the DREDGE THOMPSON could connect with when dredging in the area. These special facilities, in addition to operational problems, could cause additional disruptions to the river ecosystems, especially in the remote areas from the main channel which would not normally receive such impacts. The potential for loss of material from the remote disposal areas due to indirect secondary movement by flood flows could be reduced, as the velocities are usually less in areas away from the main channel. Similar losses to wave wash action could also be reduced. The value of the sandy dredged spoil areas as informal recreation beaches could be reduced as dredged material placed in these remote areas would probably have limited access. The type of floodplain area affected would be somewhat different, probably affecting more of the floodplain forest than the backwater slough areas as under current operations. A smaller total area for spoil disposal would be required by virtue of having fewer disposal areas.

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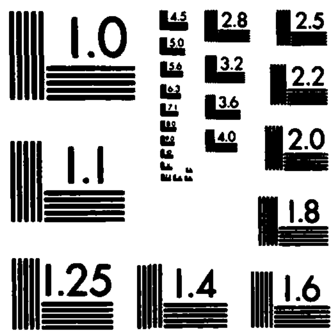

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6.94 Implementation and use of remote disposal areas would depend on the ability of all concerned interests to cooperatively select such sites and reach agreement on the ultimate use of the area and the justification for the significant increase in handling costs of the material. Movement of the material to these areas would be dependent upon sufficient dredge plant capability. This would involve a major acquisition of additional dredging equipment. Special provisions would probably be required to provide access to the backwater area disposal sites for the shorepipe and/or floating pipe. This might include a special type of dredging equipment. The reduction in area affected would probably result in reduction of the adverse impacts on the river ecosystem, although the types of impacts would probably change. A more beneficial use of the material placed in the remote location would depend on the type and amount of additional work done to the material after it is placed. The placement of the material alone in these areas does not necessarily imply a more beneficial use for the material.

6.95 Central disposal area - Use of a single central disposal area within a pool for placement of dredged spoil would limit the number of areas disrupted within a pool and localize any adverse ecological impacts. Other beneficial developmental uses of the dredged spoil areas might be enhanced by having one large area available for such uses. Reduction of the number and size of areas where dredged spoil would be placed should reduce the overall adverse environmental impacts of present operation and maintenance activities.

6.96 All material dredged within a navigation pool would be placed at a single disposal area within the pool. The selection of the area to be used for the central disposal site would have to be completely coordinated with all interests. The distance from the most frequent and large volume dredge cuts, the potential developmental uses of the area, and the type of ecosystem being affected would all play important roles in the selection of the area.

6.97 Expansion of dredge plant capability would be required in all cases, although the total amount of expansion would vary from pool to pool. In the case of several longer pools, these distances would probably exceed 10 miles. Equipment handling and safety would be major problems with these lengths of pipeline. The dredge plant capability requirements would be increased over those considered for other placement alternatives. The cost of implementing this placement alternative would normally be one of the most expensive. Special facilities for getting the material across backwater areas would be necessary for some of the central disposal sites. The problems associated with this would be similar to those discussed in Remote Disposal. Due to the long distances the dredged material would have to be transported in several pools, a more economical procedure might consist of working with a shorter total length of dredge

plant and redredging the material to get it to the final disposal site. This consideration might be used to best advantage where a relatively small volume of dredging is involved and where the total distance to the disposal site exceeds the plant capability. Utilizing the technique of redredging or rehandling the material reduces production and also increases turbidity at the rehandling site. In spite of these adverse impacts, this procedure might be used very effectively in some isolated cases to reduce the overall adverse impacts of dredge spoil placement. The major differences between the disposal measure and other placement measures are that only one location would be used, the total area affected by future dredge spoil placement would be reduced, and greater costs would be involved. The other effects both direct and indirect, would be similar to those for selective placement and remote disposal.

6.98 The use of a central disposal area would have primary value only in those areas where other placement alternatives do not offer acceptable solutions to the placement problem. The reduction in number of acres affected would probably not offset the increased expenditures of resources involved in moving the material long distances. A suitable area of sufficient size would have to be available.

6.99 Remove from floodplain - The continual placement of dredged material within the floodplain areas has resulted in many large sandy areas replacing the aquatic and terrestrial ecosystems which they have covered. The dredging of the sandy bedload from the river channel onto areas adjacent to the channel results in a greater total accumulation of river sediments within each navigation pool. Removal of the dredged spoil from floodplain areas would tend to slow the filling process of floodplain lands and tend to prolong the life and value of the natural aquatic and terrestrial systems.

6.100 Due to the relatively deeply entrenched valley of the Mississippi River, with the exception of several river terraces which are mostly developed for either agricultural or urban uses, removal of the dredged spoil from floodplain areas with the St. Paul District portion of the Mississippi River would most likely consist of a two-stage operation. The dredged material would first have to be moved from the dredge cut location to a temporary stockpile location at the edge of the floodplain and then the material would have to be rehandled from the stockpile area to the site of final utilization or disposal. The two phases of the operation are different as regards the location, accessibility, and methods of moving the material; however, they have similarity as regards the relative impacts of placing material in a location where it would not be placed under natural conditions.

6.101 Moving the material from the dredge cut location to a suitable stockpile area on the edge of the floodplain where the material would be accessible to other forms of transportation would require the use of either a pipeline or shuttle barges. Although no dredge plant expansion would be required in some areas, the majority of dredge cuts are located in areas that would require extensive increases in

placement capability. Use of a shuttle barge system might be engineering by feasible for a hydraulic dredge. The alternative measure of increased dredge plant capability treats these methods in more detail.

6.102 After the dredged material is located at a stockpile area, the material must then be loaded onto another mode of transportation, either truck, railroad, or barge, and be moved to the final disposal area. If appropriate loading facilities do not exist for a particular transportation mode at the stockpile area, facilities would have to be constructed. This might include a new railroad siding, barge terminal, or road, and possibly conveyor systems.

6.103 The final disposal sites would be out of the floodplain area. Most of these non-floodplain areas would be located in the upland areas adjacent to the river and probably not on the river terraces within the river valley proper. There are conceivably many areas in the uplands within a 50-mile radius of the river where the material could be placed; however, actual suitable or desirable sites have not been located or determined.

6.104 Removal of the dredged material from the floodplain could have many resultant effects and impacts, several quite important. The major effects would involve the extra effort expended in handling the material and the net resultant effects at the final disposal site.

6.105 The cost and effort involved in handling the material would probably increase severalfold for getting the material to a suitable stockpile area within the floodplain. In several favorable instances the unit handling cost of placing the dredged material at a stockpile area may only result in an increase from about \$0.30 per cubic yard to about \$0.50 per cubic yard. However, for the majority of dredging locations, this cost would probably exceed \$1.50 per cubic yard and, in cases where the distance to the stockpile area exceeds two miles, the unit cost could be in excess of \$2.00 per cubic yard. The added costs of rehandling the material at the stockpile and shipping costs to final disposal area could also be high. A handling-loading cost of about \$0.25 per cubic yard would be incurred each time the material would be rehandled. Shipping costs by various modes of transportation, as illustrated in Exhibit 191, vary depending on the mode of transportation and the distance to be moved. Use of barges or the railroad to move the material out of the floodplain would require at least one more additional handling than if trucks were used. Railroad and barge rates would probably be cheaper for shipping long distances (such as over 30 miles); however, the location of the final disposal point would be the most important factor in determining which type of transportation would be best suited and most economical. Because the closest non-floodplain areas are away from the river, barges would not be best suited unless the material were to be shipped up or downriver. As

an example, shipping costs to move the material about 25 miles would be about $0.25 per cubic yard by barge and about $2.00 per cubic yard by truck or railroad. Usually the longer the distance shipped the cheaper the rate per mile, as illustrated by the railroad rates in Exhibit 191. The total unit cost of removing the dredged material from the floodplain could range from $4.20 to in excess of $8.60 per cubic yard; the exact cost of removal from each dredge cut location would depend on the particular conditions at the site. The cost and availability of land for ultimate disposal are not included in the above costs.

6.106 The effects on the natural river ecosystems from removing the dredged material out of the floodplain could be important. The rate of total sediment accumulation in the navigation pools would be reduced from present rates due to the removal of the dredged bedload material from the floodplain. The effects on aquatic ecosystems due to the placement or indirect movement of dredge spoil deposits would be reduced; however, the loss of backwater areas due to the accumulation of sediments that are not being dredged would continue as under present conditions. The effective biological life of the navigation pools may not be significantly affected by removing the dredge spoil from the floodplain if the natural phenomenon of backwater areas being filled with sediments other than dredged material is the overriding influence.

6.107 Areas used for dredged spoil stockpiles at the edge of the floodplain would be converted from their natural ecosystems to sandy areas where the material would continually be placed and then removed.

6.108 The net biological and social impacts of how and where the dredged material is placed outside of the floodplain must be included in the assessment of this alternative. However, these impacts cannot be measured at this time since no specific suitable or desirable areas for use were identified. The sandy dredged material would have a tendency to degrade the quality of natural areas, farmland, or other upland areas if no further treatments were applied to the dredged material at the final disposal areas. Utilization of the material in a beneficial manner, such as highway sanding, fill material, etc., could have a probably net beneficial impact on the natural environment. Commercial uses of dredged material are discussed in greater detail in a following section.

6.109 Increases in railroad, barge, or truck traffic would result depending on the mode of transportation used. Both beneficial and adverse impacts could be associated with this increase, including such items as increased employment, increased wear and tear on highways, and increased fuel consumption. The impacts of construction of handling facilities, such as railroad sidings and additional barges, railroad cars, etc., would also have to be accounted for. Most railroad cars for sand and gravel carry a maximum of about 35 cubic yards (50 tons) per car, although

some newer railroad cars being used on unit trains carrying up to about 70 cubic yards (100 tons); trucks can carry from about 5 to 25 cubic yards; and barges vary in capacity from about 165 to 1,000 cubic yards. Depending on the mode and size of carrier used, the number of railroad cars, etc.which would be needed would vary. Exhibit 192 illustrates the number of railroad cars, trucks, or barges per day which would be required to remove from a stockpile area the material being dredged for the 9-foot channel project. A year-round removal operation would provide for a reduced quantity of equipment to be loaded each day; however, the winter season would preclude efficient operation during cold weather. A 6-month warm weather operation would probably be the more feasible approach to such an operation.

6.110 There are locations where this alternative might be implemented with somewhat minor changes in dredge operation procedures and limited modifications to the secondary mode of transportation facilities. However, most major dredging locations would require extensive expansions of existing dredge plant capability and a large amount of construction of auxiliary handling facilities in stockpile areas, including railroad sidings, etc. The great increases in unit costs for total handling of the material would probably not be significantly offset by the economic benefits derived from the potential sale of the material which is discussed in the alternative measure of commercial use.

6.111 The actual desirability of removing the material from the floodplain must be based on the selection of final disposal and utilization sites and the comparison of the net gains and losses involved.

DREDGE OPERATIONS

6.112 Basic modifications or changes which could be made either to the type of equipment used or to the method of operating the existing equipment could provide for varying degrees of reductions of the adverse impacts caused by the operation and maintenance dredging activities. The basic type of alternative equipment and operations considered include the following:

a. Type of dredge

b. Cutterhead

c. Size of dredge cut

d. Dredge openings into backwater areas

e. Increase dredge plant capability

6.113 Type of dredge - The current types of dredges being used in the St. Paul District for maintenance and operation of the 9-foot channel consist principally of the DERRICKBARGE HAUSER (767), the hydraulic

DREDGE THOMPSON, and privately-owned dredges most of which are hydraulic dredges. The basic methods of handling the dredged material differs significantly from the hydraulic dredge to the derrickbarge. Other types of dredges offer slightly different variations of handling the dredged material. The capability of moving the dredged material farther, faster, higher, in greater volume, or in a more versatile fashion may result in fewer adverse impacts to the river ecosystems. Adverse aspects of the present dredging practices include turbidity at both the dredge cut and at the dredge spoil area, the physical limits of spoil movement capability, and the relatively large area required at the disposal site.

6.114 The basic dredging methods used to move material from shoal areas in the navigation channel include mechanical dredging and hydraulic dredging. The basic difference in the two types of dredging is that the mechanical dredges handle the material as a bulk solid, whereas the hydraulic dredge mixes the dredged material with water and transports the mixture as a slurry to its disposal area.

6.115 The basic types of mechanical dredges include clamshell, dragline, dipper, and ladder dredges.

6.116 The clamshell and dragline dredges are operated from a derrick mounted on a barge. They are primarily used in close quarters where mobility of equipment presents problems for most other types of dredges. They work well in silt, gravel, sand, and stiff muds and are particularly effective where there are obstructions and trash. In hard materials the production is rather poor and in stiff and hard clays the clamshell is unsuitable. The depth to which they can dredge is limited only by the length of cable and boom, thus they can dredge deeper than most other dredges. As the digging action depends upon the weight of the bucket, they do not have sufficient penetrating power in hard materials to get a full bite. The DERRICKBARGE HAUSER is of the clamshell dredge type. (Typical production rate: 40 - 150 cubic yards per hour).

6.117 The dipper dredge is a power shovel operating from a barge. It is most effective in hard materials such till and soft and broken-up rock and shales. It works well where there are obstructions such as boulders, snags, or timbers. The digging depth is limited by the boom length, 65 feet being about the maximum. (Typical production rate: 50 - 250 cubic yards per hour).

6.118 The ladder dredge is probably the oldest type of dredge in use today. This dredge does its excavating with a continuous chain of buckets which are supported on an inclinable ladder. As the buckets go along the ladder, they pick up material at the lower end, carry it up the ladder, and dump it into a trough as they reach the top. This dredge has generally poor mobility due to the necessity for a large number of mooring lines and is unstable under tow because of a high

center of gravity. When traffic is limited and where there are rocks, piling, or other obstructions, this type of dredge is highly practical. It works well in soft clay and rocks. The ladder dredge has low efficiency compared to other types of dredges due to the extra power required to turn the bucket chain. Costs for this type of dredging are about twice that of grab dredging. (Typical production rate: 10 - 1500 cubic yards per hour, depending on the size of dredge and buckets.

6.119 The hydraulic dredges consist of several basic types, including the plain suction dredge, the draghead (hopper) dredge, and the pipeline-cutterhead dredge. The plain suction and draghead dredges are similar in hull construction to a regular ship, with a suction pipe extending from the bow or sides. High pressure water is used to break up the material to be dredged with the suction dredge and it is sucked up similar to a vacuum cleaner. The plain suction dredge operates best when it remains stationary and dredges a hole into which the surrounding sand can move. In hard materials they are unsuitable. The draghead dredge uses a suction line which drags along in contact with the bottom while the dredge is in motion. The material can be discharged into hoppers within the dredge, into barges alongside, sidecast in open water, or pumped ashore through a pipeline arrangement. This type of dredge is used principally in deep water.

6.120 The pipeline-cutterhead dredge is essentially a combination of all other dredges. Its prime function is to excavate and move material to another location without rehandling, making it very versatile. The size of the dredge is classified by the diameter of its floating discharge line. The DREDGE THOMPSON is a 20-inch hydraulic pipeline-cutterhead dredge. For most dredging, the pipeline-cutterhead dredge is the most economical and practical method of handling dredged material.

6.121 The amount of material handled is a function of the size and length of the discharge line and the type of material. The velocity of material moving through the pipeline must be above a certain minimum. For fine sand, the minimum velocity is about 10 to 12 feet per second and a maximum solids percentage is about 20 to 30 percent. A 20-inch dredge pumping a slurry with 20 percent solids at a velocity of 12 fps would have a production rate for fine sand of about 700 cubic yards per hour. This rate does not include time spent unproductively in breaking floating line to allow vessels to pass. The bucket type dredges would generally create a greater amount of turbidity throughout the water column in the area of the dredge cut, whereas the turbidity caused by the hydraulic dredge in the area of the dredge cut is located primarily at the cutterhead.

6.122 The turbidity at the location of spoil placement can vary substantially depending on the disposal method used. With bucket type dredges, a much greater percentage of the material handled is solids and as such would normally cause less turbidity in the disposal area. However, with

the hydraulic dredges, only about 20 percent of the material passing through the pipeline is solids, the rest being water. This high percentage of water in the slurry causes greater turbidity in the disposal area and finer material is moved more readily out of the actual location of material placement.

6.123 The mobility and efficient rate of production of the dredge is important. The grab and dipper dredges are very mobile and capable of economically removing smaller quantities of material in restricted areas, whereas the hydraulic dredge, although fairly mobile, operates more economically in larger dredge volume areas. Use of an inefficient dredge tends to increase the unit cost of handling dredge material. The unit cost of moving material varies significantly depending on the suitability of the dredge for a particular job. Cost differences of over 500 percent can be realized by moving the same material with a different type of dredge.

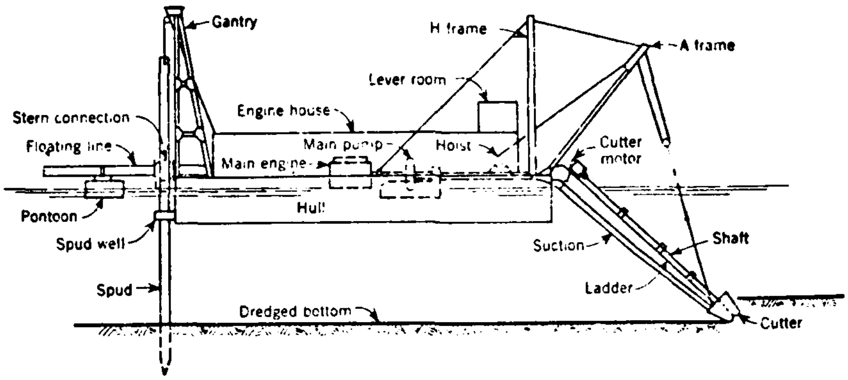
6.124 The dredging requirements in the St. Paul District necessitate both a small, easily-manueverable dredge to handle small volume dredging in close quarters, and a large volume mobile dredge to handle the many and varied larger dredging requirements along the main channel of the Mississippi River from Minneapolis-St. Paul, Minnesota, to Guttenberg, Iowa.

6.125 The present combination of the DERRICKBARGE HAUSER (767) and DREDGE THOMPSON offer this capability. Other basic types of dredges either offer similar capabilities or do not have the capability that is required for these dredging conditions. Turbidity amounts could be changed in the dredge cut or spoil deposit areas, but a reduction in turbidity in one location would usually result in an increase in the other location.

6.126 Turbidity control at the disposal site seems to be the more significant adverse impact to be corrected. Elimination of the hydraulic dredge and using only the bucket type dredge would substantially reduce this impact; however, this would require a complete change in the dredging concept in terms of efficiency of operations and operating costs.

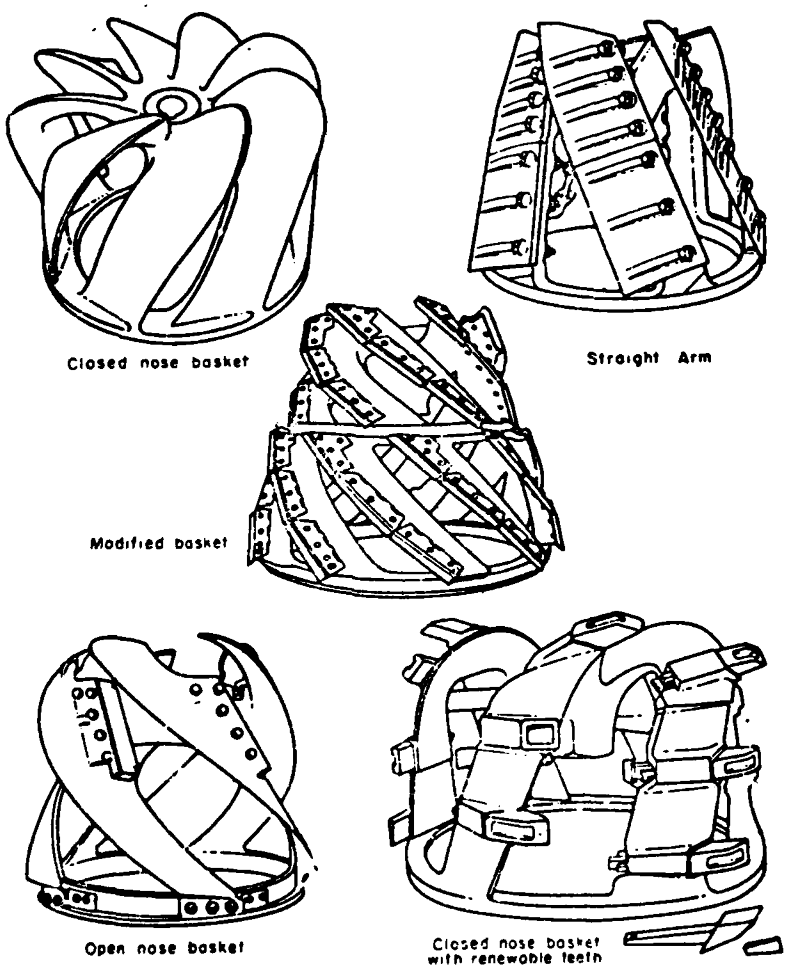
6.127 For major turbidity or fine material control in the St. Paul District's dredge operations, other alternative methods need to be considered for a major reduction of these adverse impacts. Increased capabilities of the existing hydraulic dredge may be more suitable for this consideration.

6.128 Cutterhead - The DREDGE THOMPSON has primary responsibility for maintaining the 9-foot channel within the St. Paul District. The DREDGE THOMPSON typifies the pipeline-cutterhead type of hydraulic dredge, the main components of which are shown in the following sketch.



6.129 With this type of dredge, rotation of the cutterhead loosens material from the face of the dredge cut, placing it in temporary suspension. The material is then drawn up the suction line, pumped through the dredge pipeline, and discharged. The cutterhead activity unavoidably generates turbidity which may have adverse impacts on the aquatic ecosystem. Modification of the cutterhead was considered as a possible means of reducing the turbidity and related environmental impacts associated with dredging operations.

6.130 The cutterhead on the THOMPSON is of the open nose basket type as shown in the following figure.



Similar cutterheads that perform the same basic function are also shown. Modifications to the basic cutterhead operation could also consist of a swivel cutterhead that would allow meeting the dr dge cut at a better angle, or a cutterhead shield that would define the flow around the cutterhead better. Removal of the cutterhead and reliance solely on the suction from the centrifugal pump to remove the bottom materials might be used in some dredging situations. Modifications to the cutterhead of the DREDGE THOMPSON could be extensive and costly depending on the particular modification.

6.131 A change of the basic type of cutterhead would probably have a minimal effect on the amount of turbidity being produced by the cutterhead operation, and the change could produce either an increase or decrease in the efficiency of the dredging operation. Elimination of the cutterhead and reliance solely on the suction of the pump would show in the turbidity being produced at the cutterhead, although the efficiency of operations would be severely affected, as the majority of shoal areas being dredged would be extremely difficult to remove without a cutterhead.

6.132 A basic modification to the cutterhead operation such as either a swivel cutterhead or a cutterhead shield could probably reduce the amount of turbidity being produced and result in a more efficient dredging operation. Also, reductions in the amount of turbidity at the cutterhead could reduce the impact of the turbidity on aquatic organisms.

6.133 Modifications to the cutterhead which might increase the efficiency of the dredging operations could result in a decrease in unit cost of dredging and a reduction in fuel consumption. Modifications that would decrease or not appreciably change the efficiency of the dredging operation could result in an increase in the unit cost of dredging and/or an increase in fuel consumption.

6.134 The adverse impacts caused by turbidity created at the cutterhead during dredging operations depend on the specific situation at each site and are related to the type of material dredged, the efficiency of the cutterhead, the current in the river, and the types of aquatic systems present in the area, especially downstream. A test, conducted in pool 8 in 1973 to monitor the effects of dredging on several ecologically significant parameters, showed that the effects of turbidity caused by dredging activities at that location were quite localized and short lived, and did not appear to be of real significance. The overall ecological significance of the navigation channel proper is comparatively minor in terms of plant and animal life, and turbidity in this area would probably not have the same degree of significance as that in backwater areas. The amount of turbidity caused by the cutterhead could be expected to be minor due to the sandy nature of the material being dredged throughout most of the St. Paul District.

6.135 A cutterhead similar to the type currently on the DREDGE THOMPSON is required to perform the dredging of sandy shoals in the St. Paul District. Any basic modifications to the cutterhead might result in changes in plant efficiency, but would probably not reduce significantly the turbidity at the cutterhead and any associated adverse impacts.

6.136 Size of dredge cut - If the amounts of material being dredged to maintain an effective 9-foot navigation channel could be reduced, perhaps the cost of dredging and the adverse impacts on the river ecosystem caused by placement of the dredged material could also be reduced. It is felt by some interests outside of the Corps that the actual widths and depths to which the channel is dredged may be greater than authorized and in effect a deeper navigation channel may actually be provided.

6.137 The depth and width to which the channel is maintained is currently based on a minimum 300-foot width in most of the pools and up to a maximum width of 550 feet on bends, depending on the degree of curvature. The dredging depth is based on the requirements for 9-foot draft vessels with 2 feet extra each for operational and overdepth characteristics taken into account. The horizontal position of the dredge cut is established by gyrocompass and visual alignment using marker buoys which have been set with surveying instruments. Reduction of the depth of dredging to the actual amount necessary for 9-foot draft vessels to navigate within the channel could consist of reducing the current dredging depth of 13 feet to 11 feet or less. The width of the channel being maintained allows for two tows, three barges wide, to pass in the channel safely. Reduction in the width of dredging would probably consist of restricting the channel width below that authorized or required for safe passage of the barge traffic. Use of short-range electronic positioning equipment might also assist in improving the accuracy of the dredge cut location in areas where the current system might introduce errors.

6.138 Dredging to provide a channel depth of 13 feet just after completion of the actual dredging operation provides a "cushion" of extra depth to prevent restriction of 9-foot draft barge traffic during a normal navigation season. Because of the high variability of sediment deposition from year to year caused by the extremely complex and variable relationships of quantity and timing of high water discharges from the Mississippi River and its various tributaries, any major attempts to provide reductions in dredging requirements in future years by dredging excessive extra quantities of material in any given year would probably have limited success. However, the quantity of dredged material to be handled at any given time could probably be reduced by reducing the depth of dredging especially since the overdepth dredging could consist of over 40 percent of the volume dredged at any given site. Caution must be exercised when reducing the depth to which the channel is dredged, as dredging to provide a channel depth of less than 13 feet at the time of dredging may cause more frequent dredging of that site, either within a navigation season or from year to year.

6.139 The variability of the actual rate of sediment accumulation in particular locations due to natural river processes and mechanics is only a portion of the reason for the "cushion" of extra depth provided when dredging. Maintenance of less than an 11-foot depth in many areas of the navigation channel would not allow 9-foot draft barge tows to use the system. The operational characteristics of the barge tows require about an extra 2 feet of depth to allow them to stop and start or change speeds significantly in the channel. When pushing fully loaded barges drafting 9-feet, the tugboats will tend to "squat" when starting from a standing position. This "squatting" consists of the stern of the tug settling in the water. Also when starting from a standstill, the extra force required by the tug to start the large mass of the barges into motion causes tremendous turbulence, high velocities, and eddy currents in the propellor area at the stern of tug. If the water depth is less than 11 feet when a fully loaded tow drafting 9 feet is starting from a standstill or experiencing an acceleration to increase speed, the high turbulence from the tug propwash tends to create "windrows" of the bottom sediments parallel to the direction of movement of the tow and just astern of the tug. The "windrows" created reduce the effective depth of the channel for the next approaching tow. In critical areas where either stopping and starting or accelerating tows is necessary, this "windrowing" phenomenon can have a "snowballing" effect and the channel depth in that area can be reduced to less than 9 feet in an extremely short period. This "windrowing" effect can cause the depth of the channel to be decreased from 10 feet to less than 8 feet within a week. The same result occurs when a tow goes aground where channel widths are inadequate for reasonable navigation. In backing off the shoal, the tug propellors create humps in the river bottom due to the heavy work in one location. As other tows contact or ground on the hump, it "snowballs" and results in less than 9-foot channel depths in again short periods of time. Such reductions in the effective depth of the navigation channel for even short periods can cause major disruptions to barge transportation of material as tugs are designed to draft 8 1/2 feet when loaded to maximize their efficiency. Because most of the barge traffic emanates from either end of the Mississippi River portion of the 9-foot channel project within the St. Paul District, either at Minneapolis-St. Paul or downstream of Guttenberg, a major reduction in effective channel depth of less than 9 feet at even one location could seriously affect the entire system. If such a reduction in channel depth were to occur in a very short period of time by the "windrowing" effect, the channel depth could potentially be reduced for some time, as the capability of the DREDGE THOMPSON and/or other dredges to immediately dredge the area to the proper depth would be dependent on the location and importance of the other work engaged in at the time. Travel time for the DREDGE THOMPSON from one end of the St. Paul District portion of the 9-foot channel project to the other is about 3 days. The DREDGE THOMPSON is also responsible for maintenance of the 9-foot channel project within the Rock Island District, for which the traverse time for the DREDGE THOMPSON would be about 3 1/2 days. The total travel time for the DREDGE THOMPSON to reach a critical unscheduled dredging job location on the channel on short notice could approach one week. Such unscheduled dredging requirements on an emergency basis could increase the cost of

dredging because of the large amount of unnecessary and unproductive travel time involved. Frequent occurrences of depth reductions due to "windrowing" and "humping" effects might:

a. Significantly increase the cost of dredging within the St. Paul District:

b. Create many adverse economic and social impacts because of barge traffic delays:

c. Require purchase of another dredge in addition to the DREDGE THOMPSON to make up for the lost production capability;

d. Require increasing the amount of contract dredging;

e. Result in an overall increase in the amount of material being handled; or

f. Create greater adverse environmental impacts by causing dredge spoil to be deposited in certain areas at more frequent intervals.

6.140 Because of the potential for increased adverse environmental, social, and economic impacts in not only localized areas along the 9-foot channel project, but also to the entire area of influence of the 9-foot channel project, reducing the amount of dredging should not be undertaken without careful study and effective monitoring. There could well be some reaches where the depth of dredging could be reduced without significantly affecting the frequency of dredging. In these areas there could be a reduction in the quantity of material being dredged, possibly by 10 to 25 percent or more. This would most likely reduce adverse impacts associated with dredged spoil in locations which must be dredged on a very frequent basis. It is not known how many of these areas would be located in the St. Paul District. The major beneficial impact of this alternative measure would be to the total quantity of material being dredged. Any adverse environmental impacts caused by the present O&M activities would probably be reduced in magnitude.

6.141 Reduction in the effective width of the navigation channel by reducing the width of the channel maintained by dredging would not allow safe two-way navigation of normal barge fleets. Restrictions at certain points in the channel to one-way traffic would create locations where special procedures would have to be implemented to assure safe passage of water craft. Such restrictions could cause bottlenecks to efficient use of the waterway. Some modifications in the amount of material dredged at any given location would undoubtedly occur. Although initial reductions in dredging requirements could occur, it is unknown what actual change in dredging patterns would develop. Reductions in dredging requirements would tend to reduce adverse impacts on the natural river environment. The project authorization would have to be modified to reduce the channel widths maintained below the minimum stated in the authorizing legislation.

Widths greater than minimum are maintained in areas (such as bends) where safe navigation so requires. Reductions in maintained channel widths in these areas would have to be justified recognizing the safety hazards involved.

6.142 The introduction of more precise positioning equipment would probably not reduce the quantity of material dredged, as the narrow channel and present positioning system do not provide significant room for error in the operation of the DREDGE THOMPSON. However, if more emphasis were placed on "accuracy of cut" than on "unit cost" of the solids moved, a more accurate positioning system might be desirable.

6.143 <u>Dredge openings into backwater areas</u> - It appears that a net loss of circulation in backwater areas is occurring within certain areas of the river system. This is due to a reduction in the size of openings into backwater areas as a result of natural deposition, detrimentally placed dredged spoil materials, and other causes. Natural causes might include the formation of deltas at either end of an opening into a backwater area or the gradual sediment buildup along the entire length of an opening. Dredged spoil piles are occasionally placed immediately upstream of backwater openings and secondary movements due to various types of erosion move the dredged materials into the openings. Continuous deposition of dredged materials in a linear pattern parallel to the navigation channel tends to reduce circulation of water into backwater areas, especially if openings into the backwater areas are blocked.

6.144 Dredge operations to reopen or create backwater openings would maintain or establish water movement into backwater sloughs and lakes from the main body of the river. Recreational uses by virtue of easier access could be increased and detrimental effects such as eutrophication could probably be alleviated.

6.145 Backwater channels can be reopened or created by using any of several types of dredges and equipment. Creation of openings through islands or narrow strips of land is possible, but conditions would differ from working with submerged materials alone. For example, trees and brush would have to be cut, removed, or otherwise disposed of. The material above the waterline could be removed by either construction equipment or by the various types of dredges, and the submerged materials could be removed principally by hydraulic dredges.

6.146 Size and costs of opening backwater channel would vary with the desired quantity of water which would enter into backwater areas and the type of equipment employed. Exhibit 193 illustrates varying costs, size, and capacity estimates according to the equipment type used in dredging operations. It should be recognized, however, that the cost figures come from major channel maintenance dredging operations which would generally be on a much larger scale than

opening of backwater channels. Therefore, it could be assumed that costs for dredging backwater openings would probably be greater than those listed in Exhibit 193.

6.147 The extent and type of impacts a channel dredged into a backwater area might have is dependent mainly upon the amount of water being carried into the backwater area and the position of its entrance point in relationship to the main river flow. In addition, the depth and size of the backwater area would be a factor in considering a specific impact.

6.148 Channel openings into backwater areas are variable in width. Openings may be wider than 1,000 feet (entrance to Pomme de Terre Slough, pool 5, RM 748) or narrower than 125 feet (entrance to Murphy's Cut, pool 5, RM 747.5). Depths and lengths are also variable. Some channels do not permit even shallow draft water craft to pass. Channels may also be over one-half mile long such as the entrance into Lake Onalaska at river mile 707.5 (pool 7).

6.149 Location of an opening in relation to the main river flow is a variable affecting the various impacts. Water entering an opening on the outside curve of the river would, for example, enter at a greater velocity than if the opening were located along the inner curve. The net change or impact occurring in backwater areas is also proportional to the ratio of inflow to standing water.

6.150 Adverse impacts associated with the opening of channels into backwater areas include the following:

a. Accumulation of dredged spoil materials on one or both sides of the channel opening as a result of construction. To avoid this accumulation, the dredged materials would have to be transported to another location. Costs would increase as a function of the distance moved and the type of terrain traversed.

b. Introduction of sandy river channel materials during periods of high flow. The relatively sterile sand would settle on the silt-organic backwater bottom areas and a drop in biological productivity could be expected.

c. Reduction of flow in the main river area might necessitate increased dredging of the navigation channel. This would depend upon the proportion of water temporarily lost from the main flow.

d. Disturbance to wildlife, specifically nesting waterfowl and other birds, might result from the greater potential for recreational access to remote areas.

Beneficial impacts could include:

a. Provision of easier access to remote areas for all forms of recreational uses.

b. Access to river-oriented municipalities might be enhanced. This could provide a possible increased source of revenue through tourism.

c. Provision of "fresh" water to backwater areas would increase the amount of dissolved oxygen available for invertebrate and vertebrate respiration. Anaerobic decomposition and its undesirable by-products should also be reduced.

d. Provision of a slight current toward the lower ends of backwater areas. This might put nutrients and/or small-sized particles such as silt, clay, and some forms of detritus into solution or suspension and possibly avoid excessive accumulation.

e. Provision for continuity of wildlife habitat. For example, waterfowl which had nested on main channel islands would have easier access to backwater sloughs and marshes. Therefore, the need to cross terrestrial habitat might be eliminated during early brooding periods and the possibility of terrestrial forms of predation may be lessened. This would also permit foraging fish to move into and out of backwater areas for spawning.

6.151 Dredging of backwater openings might be initiated where and when it could be determined that reduction of water circulation is directly attributable to Corps' activities, and if such actions are justified and funded. An opening might be dredged when dredged material is improperly placed and directly or indirectly blocks the original opening. Opening of backwater areas could be initiated to permit backwater circulation and subsequent flushing of the closed system to avoid excessive buildup of organic materials, provide recreational accessibility, and permit wildlife, fish, and aquatic invertebrates to pass through. Both pure and applied research is needed in determining which areas might benefit or be harmed and how large an opening is required for specific needs. Relatively small areas could be experimentally opened and closely monitored for changes in water chemistry, changes in vegetation, and fluctuations or replacement of aquatic invertebrates.

6.152 Beginning in the early 1960s, concern regarding the environmental and recreational effects of the maintenance dredging began to surface. At that time the Corps of Engineers took the position that it lacked authority to engage in operations and expend funds for reasons other than channel maintenance. In July 1967, the St. Paul District forwarded a recommendation to higher authority that a study be undertaken regarding the possibility of backwater and off-channel dredging for recreational and environmental enhancement. It was determined that no such authority existed but the Corps recognized that such a study would be appropriate. In May 1972, the St. Paul District again

recommended that consideration be given to exploring the possibility of off-channel dredging, recognizing that present statutory authority would not permit such an activity. As yet, this and other recommendations have not resulted in a change in such authority.

6.153 However, in a letter to the Division Engineer of the North Central Division, which was subsequently transmitted to the St. Paul District, the Office of the Chief of Engineers indicated that there are situations where back channel dredging work may be justified at Corps expense. In locations where it can be determined that our maintenance dredging operations have in fact contributed to back channel clogging or other unacceptable environmental damage, it is appropriate that Corps of Engineers authority permit the provision of suitable remedial measures. Guidelines are given in the letter for methods of determining those areas to which this authority applies, and how the funding and coordination should be carried out.

6.154 Increase dredge plant capability - This measure is being considered for two primary reasons. First, the limited capability of the present dredge plant is a major factor necessitating continued disposal of the dredge spoil in areas considered detrimental to aquatic and terrestrial habitat. Second, increased plant capability is an integral part of many of the alternative plans for handling the dredge spoil.

6.155 The DREDGE THOMPSON is the primary dredge plant for maintaining the 9-foot navigation channel within the St. Paul District. The THOMPSON presently has a working radius of about 1,600 feet from cutterhead to shorepipe. The shorepipe can then carry the dredged slurry up to 900 feet further to the selected discharge point. It is this restricted radius of operation which is responsible for continued spoil disposal in locations which have caused concern among many interests, especially environmental and conservation interests.

6.156 Other measures relative to the present plant capability were similarly reviewed to determine their significance with regard to placement of spoil and possible applicability in alternative plans for spoil disposal. For instance, the height of the discharge point above the water surface and the volumetric rate of dredging are both individually important as well as interrelated with the distance the slurry can be pumped.

6.157 The height of the discharge point may become more important within a few years as development of new spoil areas becomes increasingly more difficult, while, at the same time, existing sites are filled higher and higher. In addition, the ability to discharge at a higher elevation may be an essential feature of certain alternative plans for spoil disposal, particularly those contemplating removal of spoil from the floodplain. Also, if the operating radius is of primary concern, the discharge elevation may be reduced in order to get a corresponding increase in horizontal pumping distance. The THOMPSON'S volumetric rate of dredging may need to be increased or decreased as necessary to effect a contemplated increase in pumping distance and/or discharge elevation, depending on the alternative plan under consideration.

6.158 Four methods of increasing operating radius and discharge elevation were considered:

a. Use barges to transport material dredged to a disposal site beyond the pumping range of the existing plant.

b. Retain the present plant, but reduce the pumping rate and discharge elevation in order to get an increased pumping distance.

c. Install a larger engine for the pump on board the THOMPSON.

d. Add a system of booster pumps in series.

6.159 Barges are used in connection with the DERRICKBARGE HAUSER. However, the limited production rate of the HAUSER, as discussed in Section 1, makes it impracticable to use similar equipment to handle the entire dredging requirements of the St. Paul District.

6.160 The Corps of Engineers Philadelphia District recently conducted a study of long-range spoil disposal systems for maintenance dredging along the Delaware River. A promising alternative consisted of a fleet of 2,500 cubic yard capacity barges loaded by a draghead-type hydraulic dredge, pushed by towboats to a disposal site up to 25 miles distant, hydraulically pumped out, and returned for the next load. Many factors would have to be considered in determining the feasibility of incorporating a comparable type of barge system in the St. Paul District. For instance, the limited draft available in the Mississippi River navigation channel (9 feet) compared to that of most of the Delaware River (40 feet) would greatly reduce barge capacities. This would necessitate additional barges and towboats, which would increase both costs and interference with commercial and recreational navigation. This latter problem would be compounded by the relative narrowness of the Mississippi River navigation channel (300 feet in straight reaches, a maximum of 550 feet in bends) compared to that of the Delaware River (400-1000 feet in straight reaches, wider in bends). In addition, if the DREDGE THOMPSON were to be incorporated as part of the system, it might be necessary to make costly modifications to the cutterhead, pump, and/or discharge line. Consideration of such a system for the Upper Mississippi River 9-foot channel project would require a detailed study to determine what components of such a system could be used and how much it would cost to implement the system. The effects and impacts of implementing such a system would depend on its actual feasibility and applicability.

6.161 At present, the velocity in the THOMPSON'S discharge line averages slightly over 19 fps (feet per second) for the time actually spent dredging. If the pumping distance is quite short, velocities may be higher. Conversely, as the operating radius approaches the present maximum of 1,600 feet, the velocities are lower. If the velocity was to be reduced even further, the operating radius could be increased substantially. For instance, at a velocity of 12 fps and a discharge

elevation of 10 feet, the operating radius of the THOMPSON might be increased by nearly a mile if all components of the THOMPSON were working at a peak efficiency. This velocity was selected to maximize the pumping distance while simultaneously providing some degree of assurance that solids in the slurry would not fall out of suspension and clog the pipeline. The additional equipment needed to take full advantage of the increased pumping distance of nearly a mile, including a push boat, a deck cargo barge, extra floating line, several belly anchor barges, and two tenders, would require an investment in excess of $2 million dollars.

6.162 Additional dredging time would have to be provided to compensate for the nearly 40 percent decrease in output which would result from this velocity reduction. This could come from time savings achieved in some other activity, such as not having to relocate the discharge point as frequently. However, an increase in operating radius would probably result in offsetting time increases as well, such as having to break the longer floating line more often for passing vessels. Therefore, any additional time would probably have to come from working more of the dredging season on a 24-hour day, 7-day week basis. Based on dredging records from 1971 and 1972, the number of hours actually spent dredging might be increased by 9 percent if the THOMPSON was utilized full-time for the entire dredging season. In this situation, the 12 fps pumping rate might be utilized up to 20 percent of the total time spent dredging. However, because of the lag time at the beginning of the dredging season involved in obtaining survey information to determine dredging requirements, the actual amount of time available to implement this technique may be much less than the 20 percent estimated.

6.163 If the reduced pumping rate was used in the St. Paul District more than 20 percent of the dredging time, a portion of the dredging in the Rock Island District which would normally be handled by the THOMPSON would probably have to be contracted to private dredging companies at a cost estimated to be about $0.90 - $1.00/cubic yard, roughly three times what it presently costs the THOMPSON to do the same work.

6.164 If the reduced pumping rate was to be used all the time, it would be necessary to keep the THOMPSON in the St. Paul District essentially full-time, with other arrangements being made for Rock Island District dredging. Thus, the unit cost of dredging at 12 fps in the St. Paul District would have to reflect four items:

a. The present unit cost, $0.33 per cubic yard in 1972.

b. The cost of adding equipment to increase the pumping distance.

c. The additional unit cost from covering essentially the same operating costs for the dredge as at present with a greatly reduced quantity of dredging, estimated at about $0.30 per cubic yard.

d. Additional costs incurred by the Rock Island District in having to handle their dredging requirements in a less economical manner, such as by contract, estimated to account for another \$0.55 per cubic yard when prorated by the St. Paul District dredging requirements. For instance, the unit cost of providing the present plant with the capability of operating at a radius of 1.16 miles would then be \$0.33 + \$0.34 + \$0.30 + \$0.55 = \$1.52 per cubic yard.

6.165 Brief consideration was given to installing a larger engine for the THOMPSON'S centrifugal pump. However, experience has shown that pump maintenance is a function of the pressure differential between suction and discharge lines. Thus, increased maintenance costs would offset, at least in part, advantages gained by installing a larger engine. Space limitations on the THOMPSON would restrict the size of engine that could be accommodated without a major renovation of the dredge. Practical limits on the pumping capability of a single engine would still necessitate a reduction in pumping rate and/or the use of booster pumps for distances in excess of present capabilities. Therefore, the alternative of installing a larger engine for the THOMPSON'S pump is considered less favorable than either retaining the present engine and reducing the pumping rate or incorporating a system of booster pumps.

6.166 The booster pump system evaluated consists of a series of centrifugal pumps spaced uniformly along the floating line. Each pump would be powered by an engine similar in size to that already on board the THOMPSON and would be installed on a booster pump barge with the necessary equipment. Each booster pump would add approximately 0.4 miles to the operating radius of the present plant if the present rate of pumping was maintained. If the pumping rate was reduced to 12 fps, each booster could add about 1 1/2 miles to the operating radius. In the latter case, attendant plant needed in addition to the booster pump barge and additional floating line would probably include a push boat, two deck cargo barges, three tenders, a fuel barge, and 14 belly anchor barges. Each such booster pump unit would have an estimated first cost of \$4,400,000 and would add nearly \$0.65 to the unit cost of handling the dredge spoil.

6.167 The same considerations that applied to the time factor when retaining the present plant and reducing the pumping rate would also apply with the addition of booster pumps. As a result, if pumping greater distances results in a net loss of time available for dredging in the Rock Island District, the unit cost of dredging in the St. Paul District must reflect the additional costs incurred by both Districts. For instance, if the THOMPSON is retained full-time in the St. Paul District, the estimated cost to provide an operating radius of 5 miles is \$0.33 + \$2.04 + \$0.30 + \$0.55 = \$3.22 per cubic yard.

6.168 Both adverse and beneficial impacts would result from an increase in plant capability. Among the obvious adverse aspects would be the tremendous cost associated with an increased operating radius, including the cost of additional equipment, the cost for retaining the THOMPSON within the St. Paul District, and the additional costs for contract dredging within the Rock Island District.

6.169 Increased fuel consumption would also be an adverse impact. The barge fleet alternative, if adopted, would include towboats and a pump-out facility, both of which would be heavy consumers of fuel. At present, the THOMPSON and attendant plant consume an average of about 2,200 gallons of #2 low sulphur diesel fuel each working day. Each booster pump and attendant equipment added to the dredge fleet would consume a similar quantity of fuel while in operation. Thus, any large pumping distance will mean fuel requirements several times that at present.

6.170 Another adverse impact might be possible interference with commercial or recreational navigation due to increased barge traffic or the longer floating line and additional floating plant associated with a booster pump system.

6.171 Few beneficial impacts would result from the increase in plant capability itself. Localized economic benefits from employing additional crewmen might be an exception. However, beneficial ecological and aesthetic impacts could result from changes in present channel maintenance activities which would become feasible with an increased plant capability. For instance, an increase in pumping distance would allow greater latitude in selecting sites for placement of spoil. This would provide the potential for alleviating problems at existing spoil sites, such as destruction or degradation of terrestrial and aquatic habitat either directly or indirectly. Aesthetics along the main river channel could be retained by pumping spoil to remote areas. Although the Corps has general Congressional authority to purchase new dredging equipment as necessary, there is currently a Congressionally-imposed moratorium on the purchase of new dredging equipment. The moratorium was imposed pending the results of a study to determine whether maintenance dredging of navigable waterways can be done more economically and efficiently with government plant and labor or through use of private contractors. To increase the dredge plant capability, an exception to the moratorium would have to be provided. The purchase of additional plant capability is also dependent on the availability of funding and subject to the Corps' policy as described in Engineering Regulation 1130-2-307, "Project Operation: Dredging Policies and Practices."

DAM OPERATIONS

6.172 The primary function of the operation of the dams is to control water levels upstream of the dam. Based on upstream water levels at

one of several points in the pool, one section of the dam, the gated control structure, is operated to control these water levels. Aside from the control exercised at the gated control structure, the emergency spillway and low flow outlets provide other means of allowing flow to pass the dam. Possible alternative measures to present dam operations would include:

a. Permanent pool level change.

b. Temporary pool level change.

c. Change control point.

d. Provide fish passageways.

e. Provide low flow outlets.

6.173 Permanent pool level change - A permanent pool level change might offset some of the adverse impacts of the present operations and maintenance activities, either by reducing dredging or by enhancing the natural environment. Permanent lowering of pool levels would not reduce dredging and probably not enhance the natural environment; therefore, only permanent pool raises will be considered in this measure.

6.174 A permanent pool raise of 1 foot is considered as the maximum practical change because pool raises greater than this would be severely limited by economic and engineering feasibility considerations. The implementation of this measure would involve raising the project pool elevation (flat pool) 1 foot at the dam. This measure would require some moderate structural modifications to the locks and dams and probably some minor modifications to the present dam operating procedures. Maintenance dredging would probably continue to be done at a 13-foot depth below flat pool in order to provide the 9-foot navigation channel.

6.175 Raising the project pool elevation by 1 foot would inundate some terrestrial habitat and thereby regain (on a quantitative basis) some of the aquatic habitat previously lost to sedimentation and dredge spoil placement. However, the inundation of low profile islands in the lower portions of the pools might be considered as an adverse impact because the islands are valuable nesting and resting areas for waterfowl. A permanent 1-foot pool raise would probably cause marsh areas to shift a short distance upstream of present locations. If such a shift did occur it would do so over a long period of time. Implementation of this measure would move the hinge point of the pool some distance upstream, thereby inundating additional privately owned land.

6.176 Raising the project pool will have offsetting effects on dredging quantities. As a short-term effect, the higher pool would reduce dredging requirements because it will take time to accumulate the

extra foot of sediment on the channel bottom before dredging is necessary. On the other hand, the higher pool level will also reduce the velocities of low and normal flows and, thereby, cause an increase in sediment deposition over the long-term. A 1-foot pool raise would increase the trap efficiency in the pools by an average of 3 percent, but most of the increase in sedimentation will probably occur in the backwater areas. Overriding these effects is the fact that the 1-foot raise will affect primarily only the relatively low flows which do not carry much sediment. At higher flows, and especially flood flows, the river profile (and, therefore, velocities and sediment deposition rates) would be the same regardless of the low water configuration. The higher flows carry, by a wide margin, most of the annual sediment load. The long-term effects of this measure on future dredging would be somewhat unpredictable without further detailed studies; however, it is presently felt that such effects would be minor. Detailed investigations would be required to determine the actual effects and impacts of a permanent raise in each individual pool.

6.177 Additional authorization would be required to provide permanent pool raises. The structural changes and real estate purchase requirements involved for implementation of a pool raise might require substantial expenditures of funds. In addition, there would be extreme controversy generated by consideration of a permanent pool raise. Immediate reactions of environmental and conservation interests could probably be anticipated as being against such a raise, basing it on the fear of adverse effects on the environment and the belief that a 12-foot navigation channel would be provided. Due to the uncertain nature of the benefits to be gained by provision of a permanent pool raise without considerable detailed investigation, the capability of this measure to alleviate adverse impacts of the present operation and maintenance activities is unknown.

6.178 Temporary pool level change - The primary purpose of the locks and dams and the present maintenance of project pool elevations behind these dams is navigation. Fisheries, wildlife, and recreational interest groups have expressed concern that more consideration should be given to their interest regarding the maintenance of water level elevations in the various pools.

6.179 This measure will focus on those aspects of the 9-foot channel operations concerning the present pool elevation management plan, the possibility of establishing variations to the present management plan, and the effect such variations would have on navigational and non-navigational activities on the river.

6.180 The present pool elevation management plan has both beneficial and adverse effects on the fisheries, wildlife, and recreational uses of the river. An attempt to minimize adverse effects would involve an intensive water level management plan fully coordinated with concerned navigational and non-navigational interest groups.

6.181 Management of water levels in various pools would be desirable to facilitate management of fish and wildlife resources. A system of controlled manipulation of water levels within an aquatic-terrestrial ecosystem provides the controller with an important tool with which the relative abundance of habitat types can be varied.

6.182 The individual pools are variable in the proportion of terrestrial habitat, marsh habitat, and deep water habitat. However, the pools in general can be divided into three distinct categories: headwaters, mid-pool, and the open, deep water section immediately above the lock and dam. Deep sloughs and wooded islands are generally found in the headwater area with little or no marsh habitat developed. The central area of the pool usually contains both the maximum proportion of marsh development and an abundance of aquatic habitat. Within the lower end of the pool the water is open and deep and, while substantial aquatic vegetation may occur, there is practically no marsh development.

6.183 The central area of each pool would probably be the target of any proposed water manipulation because the effectiveness of controlled water level fluctuations as a management tool would be greatest there. There would be two reasons for this: first, the central pool area usually has the most extensive marsh development; second, water level fluctuation will have the greatest effect (i.e., more terrestrial habitat will be exposed or inundated) in the central pool area.

6.184 Examples of methods of fish and wildlife management by water level manipulation could be:

a. Controlled drawdowns.

b. Controlled pool raises.

c. A combination of the above two methods.

6.185 The above methods or others could be initiated on a uniform basis covering a group of two or more pools, by initiation of a rotation system for the application of controlled water level fluctuations among the pools, or by establishment of separately controlled water level fluctuation plans for each individual pool. The applicability, timing, frequency, and duration of any proposed water level manipulation should be evaluated initially on a pool-by-pool basis. It is possible that at least some of the pools would not be benefited by controlled water level manipulation.

6.186 The necessity of maintaining a 9-foot minimum depth navigation channel severely limits the extent of drawdowns during the navigation season, whereas temporary controlled pool raises would probably not affect navigation. Realizing that these two considerations would be incorporated into any proposed water level manipulation plan, such

a plan would probably have a minimal effect on navigation.

6.187 The effects and impacts of controlled water level manipulations on fish and wildlife resources would vary depending on the method, time, frequency, and duration of the manipulations.

6.188 According to Giles (1969)* the definition of wildlife management "is the science and art of changing the characteristics and interactions of habitats, wild animal populations, and men in order to achieve specific human goals by means of the wildlife resource." For purposes of simplification, the above definition will be considered applicable to fisheries management on a generalized basis. This definition of fish and wildlife management indicates that certain species will be "managed" by promotion of optimal conditions for selected species. The creation of conditions which are optimal for selected species may occur at the expense of non-selected species.

6.189 Within the scope of this measure, it would be impractical to attempt an evaluation of all impacts of the numerous possible variations in water level manipulation methodology. Therefore, only two generalized examples will be discussed, a temporary pool raise and a winter drawdown.

6.190 In general, the utilization of controlled water level raises would be for the purpose of thinning out expansive dense stands of emergent or submergent aquatic vegetation. Solid stands of emergents in a marsh are not generally desirable. Most wildlife in a marsh prefer the "edge effect," or interspersion of various types of vegetation. When dense, solid stands of emergents do occur, water level raises may provide a means of changing the stands and creating the interspersion desirable in habitat management. The thinning out of expansive stands of submergent vegetation may or may not be desirable depending upon management objective. For example, thinning dense stands of submergent vegetation would increase boating accessibility into these areas thereby increasing recreation potential. However, some species of submergents are valuable food sources for waterfowl during fall migrations. Water level raises could interfere with the availability of this food source to migrating waterfowl. The thinning of aquatic vegetation in areas which which are subjected to strong currents or winds could also generate turbidity which could be detrimental to game fish, to the remaining vegetation, and to water quality.

6.191 Stabilized water levels during the growing season sometimes are preferable when production of desired species of submergent aquatic

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*Giles, Robert H. (Editor), 1969. Wildlife Management Techniques. The Wildlife Society, Washington, D.C. 623 pp.

vegetation is the management objective. However, impoundments that have been held at stable levels for too long can build up an accumulation of undecayed plant material. Under such conditions there is often a decline in the production of desired species of aquatic plants. Drawdowns permit the aeration of bottom sediments thereby stimulating decomposition and releasing nutrients that are bound up in undecayed plant material. Organic decomposition also retards the gradual filling of shallow impoundments by the accumulation of aquatic vegetation. Drawdowns can be important in improving production of valuable submergent aquatic plants such as sago pondweed or valuable emergents such as the smartweeds.

6.192 As previously stated, the potential for utilization of drawdown as a management tool is limited due to navigation considerations. Winter drawdowns, while not interfering with navigation, would involve many other considerations, such as the effects upon fish. A previous winter drawdown within the St. Paul District 9-foot channel was recorded by Green, et al (1964)* p. 565:

> "Winter drawdowns apparently improve the germination of seeds and encourage submerged aquatics to come back with new vigor. On the Upper Mississippi River, levels were held low during the winters of the early forties, because enough water had to be made available on the lower pools of the river to aid in floating ships downstream and for hydroelectric generation at Keokuk, Iowa. Those drawdowns at the outset were viewed as potentially detrimental to waterfowl by sportsmen and conservationists, but it turned out that the aquatic growths that developed were among the best ever recorded. Seed production increased markedly."

6.193 A winter drawdown would probably create adverse conditions for many fish species and muskrats. In general, panfish, roughfish, and northern pike should be affected the most because these fish inhabit the shallow backwaters, ponds, and sloughs where winter kill conditions would be the greatest. Walleyes and other fish inhabiting the tailwaters, side channels and main channel borders would not be greatly affected by a winter drawdown. It might be possible to reduce the potential winter kill to fish by lowering water levels slowly and by deepening backwater channels allowing the fish to escape into deeper water. A winter drawdown would probably greatly reduce the muskrat population of the affected pool. This impact could not be offset, but a managed increase in trapping pressure in pools planned for winter drawdown might reduce the winter loss of animals. Recreational ice fishing and commercial fishing activities would probably be adversely affected by winter drawdown. However, winter drawdown in some cases might have a concentrating effect on commercial fish species.

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* Green, W. E., L. G. MacNamara, and F. M. Uhler. 1964: Water Off and On. pp. 557-568. In J. P. Linduska (Editor), Waterfowl Tomorrow. U.S. Government Printing Office, Washington, D.C. 770 pp.

6.194 The application of any water level fluctuation management which would benefit fish and wildlife resources, would also benefit the consumptive and non-consumptive recreational uses of those resources. Recreational boaters would probably benefit from measures that would expand accessibility in the guts, chutes, side channels, and backwater areas.

6.195 The applicability of controlled water level fluctuations as a fish and wildlife resource management tool in the St. Paul District 9-foot channel project would be governed by the following considerations:

a. Navigation was the purpose for the original construction of the 9-foot channel project. The required maintenance of a navigable channel during the navigation season limits the possibilities for drawdowns. Temporary pool raises would not have an adverse effect on navigation.

b. "Anti-Drawdown Law" (Public Law 697, 1948), Sec. 5a of that law states that the U.S. Army Corps of Engineers "is hereby directed to give full consideration and recognition to the needs of fish and other wildlife resources and their habitat dependent on such waters, without increasing additional liability to the Government, and, to the maximum extent possible without causing damage to levee and drainage districts, adjacent railroads and highways, farmlands, and dam structures, shall generally operate and maintain pool levels as though navigation was carried on throughout the year."

Therefore, any controlled pool fluctuation other than minor pool raises or drawdowns (less than 1 foot) would be in violation of this law. If controlled water level fluctuations were determined to be desirable, the "Anti-Drawdown Law" would have to be amended.

c. The control of pool levels beyond present limits would require varying degrees of modifications to the present structures. Temporary pool raises of up to 1 foot above project pool level during flat pool conditions could probably be handled without major structural changes to the locks and dams. Such a pool raise would require installation of temporary height additions to the emergency spillways, such as flashboards. No control could be exercised over pool levels during high flow periods, only during normal and low flow periods. For temporary pool raises of over 1 foot, major structural changes may be required, not only at the locks and dams, but possibly also in other adjacent facilities throughout the pool, such as riprap on railroads, etc. Any specific temporary pool raise would have to be further investigated on a case-by-case basis to determine the amount of modifications required.

d. As part of the 9-foot channel project, the Corps of Engineers purchased either flowage easements on, or in fee title, all land lying between ordinary high water and 3 feet above the flat pool level,

from the lower dam to the control point of each pool. If a proposed pool fluctuation resulted in higher than normal water levels, an easement analysis would be required. The easement analysis would determine the necessity of acquiring additional flowage easements or fee titles to property potentially affected by such a pool fluctuation.

e. The topography of the pool bottom is variable between pools. Those pools that have basins of relatively low gradient with gently sloping banks would be affected most by controlled pool fluctuations, because the greatest degree of bottom exposure or inundation would occur in this situation.

f. Local and regional public opinion would be an important part in the consideration of any controlled water level fluctuation proposal.

g. The potential adverse or beneficial impacts on such local economies as recreational-oriented commerce, commercial fishing, trapping, etc., resulting from controlled water level fluctuations would be evaluated on a pool-by-pool basis. The findings of these evaluations would be an important consideration in determining the applicability of water level manipulation in a given pool.

h. It is anticipated that any consideration of controlled water level fluctuation as a fish and wildlife resource management tools would be initiated by a recommendation from one or more of the concerned Federal and State agencies.

6.196 Attempted integration of navigational and non-navigational activities on the river presents a complexity of problems concerning both compatible and competitive uses of the resource. The present method of water level management does not appear to result in an optimal situation for any of the uses of the river. The present operation is instead a compromise that the various interests have more or less adjusted to. Any change in this method of operation will raise objections from some of the interests. Therefore, if a water level manipulation plan were initiated in a given pool, it should be done with the aim of resulting in a net long-term benefit to the whole resource.

6.197 Change control point - Navigation pools within the St. Paul District are regulated to maintain a relatively constant water surface elevation (project pool) at the primary control point of each pool.* The location of the control point in a given pool determines where the most stable water levels will be; other areas in the pool will have water level fluctuations somewhat greater. Rather strict regulation must take place so that these fluctuations do not cause flooding on private lands. Thus, regulation often does not provide the maximum benefit to fishermen, hunters, and other recreationists in certain areas of the pool. There have been

* The primary control point for pool 10 is at the dam. Refer to "Project Description" (Sec. 1) for detailed discussion of the dam operation in each pool.

instances when hunting and fishing areas have been converted into mud flats by manipulation of dam gates. Recreationists on the river feel that their interests should receive primary consideration in the manipulation of water levels during any given period, and they are usually more concerned about low water conditions than high water conditions. However, fluctuating water levels can have adverse biological effects. Therefore, it is the purpose of this measure to investigate the potential for locating the control point in the "most beneficial" location in each pool.

6.198 In order for water to flow in a river, a downstream slope in the water surface must exist. As the flow rate increased from zero, there also is an accompanying increase in slope from a flat water condition. Two ways to provide this slope in navigation pools are:

a. Maintain a constant minimum elevation at each dam and let the water surface elevation always increase from there.

b. Maintain a constant elevation at some point midway in each pool (control point) thereby necessitating a lowering of water surface elevations at each dam to provide the needed slopes (drawdown). This concept is presently in operation for pools 2 through 9 in the St. Paul District.

6.199 If there was no flow in the river, each pool would be flat at the respective project pool elevation. However, the Mississippi River has always had water flowing in it and the water surface in each pool has always had some degree of slope in it. As flows increase, the slope within each pool must also increase or the dam will impound water.

6.200 If the control point for a given pool is approximately at midpool, a drawdown at the dam will probably be required to provide the slope during rising stages. However, if the control point is at the dam, the water surface elevation in the midpool area will fluctuate to a greater degree than with a midpool control point.

6.201 The ecological impacts of water level fluctuation resulting from present dam operations are variable between pools. The degree of apparent ecological impact ranges from "least significant" in pool 7 where there is no drawdown, to "most significant" in pool 10 where water fluctuations cause the greatest impact.

6.202 In pool 10, there is more slough and marsh habitat in the lower 1/3 of the pool than any other pool in the St. Paul District. Drawdown is particularly damaging, especially in early summer during the spawning season and in the fall during waterfowl migrations. The reduction of permissible drawdown from 2 feet to 1 foot in 1971 may have partially relieved this problem. However, there is still the problem of fluctuating water levels at Clayton, Iowa. For the most part, these fluctuations in water surface elevation at Clayton are the result of natural increases in inflow into pool 10 coupled with the time lag required for the dam to stabilize the pool elevation. As a result of these

phenomena, there have been slopes in water surface elevation as great as 2 feet in 9 miles between Clayton and dam No. 10. These water level fluctuations have placed a stress on all marsh communities in the lower 1/3 of pool 10.

6.203 Drawdowns can affect recreational activities by adversely affecting aesthetics and accessiblity. The inundation side of water level fluctuation can also interfere with recreational activites. For example, the inundation of a duck blind interferes with duck hunting, etc.

6.204 Operation of the dams is a highly technical procedure involving inflows from the entire basin and the maintenance of authorized water levels. In the St. Paul District, pools 2 - 9 are operated with the control point at the intersection between project pool elevation and the pre-project ordinary high water mark. The principal reasons for using this method of controlling the pools is that only the area between the control point and the lower dam will be affected by the operation of the dam. This reduces the cost to the Government for acquiring flowage rights. The Corps of Engineers purchased all land lying between ordinary high water and 3 feet above flat pool, from the lower dam to the control point of each pool. The purchase of real estate or flowage easements upstream of the control points was unnecessary because land lying above ordinary high water would not be flooded any more often than would occur in the natural state.

6.205 With the exception of lock and dam No. 7, all locks and dams in the St. Paul District from No. 2 through No. 10 are operated with some degree of drawdown at the dam. Originally, drawdowns varied from a minimum of 2.0 feet to a maximum of 4.0 feet. Present drawdowns are limited to a maximum of 1.0 foot. The reductions in the amount of drawdown have come about because of the increased hydraulic efficiency of the main channel over pre-project conditions at low to moderate flows. This increase in efficiency is primarily a result of channel dredging, straightening, and overbank clearing.

6.206 The most beneficial location of the control point in each pool for recreational and ecological interests would be where the most stable water levels were desired. Depending on the topography of a given pool, this location would probably be in the middle 1/3 of the pool where the most extensive marsh development generally occurs. This is the present situation in pools 2 - 9 in the St. Paul District. However, this method of operation necessitates drawdowns at the dam. Therefore, any potential adverse effects of drawdowns at the dams should be weighed against maintaining the control point near midpool.

6.207 Elimination of drawdown at any dam in the future would probably require the purchase of additional real estate or easements some distance above the control point. It appears that there is little potential to further reduce drawdown based on increased hydraulic efficiency insofar as the optimum probably has been reached. Further re-

ductions in the amounts of drawdown at the dams would have adverse ecological impacts as many acres of marsh habitat would be inundated in the central pool area.

6.208 As discussed in the Environmental Impacts of Operation and Maintenance (Section 4), pool 10 is different from all the other pools in the St. Paul District in relation to the location of the marsh habitat and in method of dam operation. With the extension of the marsh to within 4 miles of the dam, any fluctuation in water level has noticeable impacts on the vegetation, fish, and game. In pool 10 water level fluctuations influenced by dam operations occur at two points: at the dam, due to drawdown (1-foot maximum); and at Clayton, due to rising or falling river stages.

6.209 A possible alternate approach would be to redesign the operation plan of pool 10 and bring it into conformity with the other pools in the St. Paul District. The shifting of the primary control point to Clayton and the resulting stabilization of the water level in the Clayton-Bagley-Frenchtown Lake region should do much to offset the present problem of short-term flooding of this area during rising and falling river stages. However, this might not be acceptable to recreation interests in the lower part of pool 10.

6.210 Another possible alternative to the present operating procedure in pool 10 could be the starting of drawdown procedures at lower river stages thereby permitting a constant elevation to be held at Clayton for a longer period than is presently possible. Recreational interests might object to this alternative also.

6.211 The considerations determining the applicability of establishing the control point in the "most beneficial" ecological-recreational location in each pool are:

a. Determination of where in each pool the most stable water levels are desired by ecological interests.

b. Determination of where in each pool the most stable water levels are desired by recreational interests.

c. The limitation of present easements or consideration of acquiring authority to purchase additional easements.

d. The engineering feasibility of any proposed changes in the present method of dam operations in the St. Paul District.

e. Legal restrictions.

Each of the above considerations would require a detailed study.

6.212 If a proposal to change the present method of dam operation in a given pool met the above considerations, and if the trade-offs in impacts resulting from the proposal were determined to be of a net benefit, the proposal could probably be implemented in the St. Paul District.

6.213 Fish passageways - The presence of the locks and dams has resulted in a blockage of normal migration movements of fish. The long-term effect of the existence of the locks and dams has not yet been determined. However, there seems to be a sustained production of most fish species affected. The possible exceptions to this are the blue sucker, skipjack herring, American eel, and the lake sturgeon. Even though the locks and dams interfere with normal fish migrations, some fish are able to negotiate the locks during routine locking procedures. This fact is supported by the results of fish tagging studies on walleye, sauger, channel catfish, and white bass published by the Upper Mississippi River Conservation Committee and the Wisconsin Department of Natural Resources. This is also supported by the presence of the white bass (*Roccus crysops*) and the freshwater drum (*Aplodinotus grunniens*) above the St. Anthony Falls. Neither species existed above the falls before the construction of the locks and dams at these locations.

6.214 Since the construction of the locks and dams in the 1930's, there has been a reduction of certain species of freshwater mollusks. It is not certain what brought about the reductions of these species. Possible explanations are:

a. Obstructing fish movement (this interferes with the normal population dispersal mechanism; i.e., clam larvae must spend a portion of their lives attached parasitically to fish).

b. Changing the river to a more lake-like environment, (associated with this are such factors as an increased rate of sedimentation, etc.).

c. Changing water quality in some areas by the effects from various pollutants.

d. Overfishing by commercial interests.

e. Combining two or more of the preceding.

6.215 Since the downstream migration of fish does not appear to be obstructed by the locks and dams, only the upstream migration will be considered here. The following methods might facilitate the upstream movement of fish through the lock and dam structures:

a. Construction and operation of fish ladders at the locks and dams.

b. Construction of culverts through the dams.

c. Creation of holes near the bottom of the miter gates to establish a slight current through the locks and thereby attract more fish to move into and out of the locks.

d. Operation of the locks during periods of no traffic to enhance fish migration between pools. This could be done most beneficially during peak fish migration periods.

6.216 Present conditions do not appear to warrant extensive modifications to the locks and dams for the purpose of increasing fish movement between pools. Non-routine operation of the locks to assist fish movement between pools could be accomplished if such a practice was determined to be beneficial. Additional study would be necessary to determine the applicability of this procedure.

6.217 <u>Construction of low flow outlets</u> - Conservation interests have expressed concern that the circulation in the backwater areas has been reduced both directly and indirectly as a result of the construction, operation, and maintenance of the 9-foot navigation channel. They believe that circulation could be improved by dredging backwater channels and/or constructing low flow outlets in the dams. This measure will consider those proposals concerned with modification to the dams and spillways.

6.218 Modification to the dams and spillways for purposes of increasing circulation in the backwater areas includes: construction of notches in the spillways, construction of culverts in the dams, and modification of existing low flow outlets to increase their efficiency. The types of structures referred to are similar to the low flow outlets presently in operation at most of the locks and dams in the St. Paul District.

6.219 During winter months, the low flow outlets constructed in the past have maintained ice-free backwaters for considerable distances downstream of the structures. This ice-free state has assisted natural oxygenation processes. However, when the low flow outlets have been obstructed due to ice jams or debris accumulation, the circulation in the downstreambackwater areas has been reduced contributing to winter kill conditions to the fish.

6.220 During the summer months, the aeration facilities (low flow outlets) have reduced the adverse impacts previously caused by low water levels, high water temperatures, algae blooms, and stagnation in the backwater areas downstream of the structures. Summer fish kills resulting from these adverse conditions have been reduced due to the improved water quality. The aeration facilities have improved water quality and provided better late summer and winter conditions for fish life. Noticeable adverse impacts have not been apparent with the presently existing low flow outlets. Improvements in aeration and scouring in the backwaters have been most beneficial where circulation channels run parallel to the main channel.

6.221 The construction of new low flow outlets or modification to such presently existing structures could be done under present authorities if a need for such action became apparent. In 1947, the Bureau of Sport Fisheries and Wildlife recommended that low flow outlets be constructed in seven of the locks and dams in the St. Paul District. Between 1947 and 1970, low flow outlets had been installed in all seven of these recommended locations and in two other locations recommended by the B.S.F.& W. in 1968. From March 1961 to May 1964, the B.S.F. & W. conducted a study designed to evaluate the effects of the aeration structures in operation at that time. The results of this study indicated that the aeration facilities were successful in improving water quality.

6.222 The low flow outlets presently in operation within the St. Paul District appear to provide adequate circulation in the backwater areas below the structures. However, additional construction could be done on these structures in the future if such action was determined to be beneficial.

LOCK OPERATION

6.223 The operation of the locks serves the primary function of allowing boats to pass through the physical obstruction of the lock and dam structures on the river and be raised or lowered to a different water level allowing boat traffic to traverse the length of the river. When the capacity of the lock is exceeded, some watercraft owners must wait until they can be "locked" through. Whenever these waiting periods become excessive, the boaters waiting to pass through the lock tend to become impatient and conflicts arise. The major conflicts are usually between the commercial barge tows and recreational boaters. Alternatives to the present operation of the locks which might alleviate these impacts include revision of locking priorities or providing an alternate passageway for recreational craft.

6.224 This measure is being considered in order to reduce the waiting period for recreation boaters desiring to pass between pools during times of peak traffic on the river. Reduction of the waiting period would decrease the number of boats waiting to be locked and would reduce the potential for hazards to public safety which include accidental passage of boats over the spillways, collision between recreation craft and commercial barge tows, and collision of boats with navigation structures. The measure could consist of a revision of locking priorities on a short-term basis and development of the auxiliary lock on a long-term basis.

6.225 Revision of locking priorities could entail the passage of recreation boats between the passage of commercial tows or even between the passage of the halves of double tows. The decision to interrupt commercial lockages and pass recreation craft would be based on one of the following principles:

a. After some maximum waiting period, say two hours, the lock operator would use a standard signal to "invite" the waiting recreation boater into the lock chamber. The recreation boater would then, in turn, signal the operator that he is ready and would then enter the lock immediately.

b. A procedure similar to that described above could be followed, except that the decision to interrupt the passage of commercial lockages would be based upon the number of recreation boats awaiting passage.

6.226 Implementation of the revised priority would be effective only if all boaters were informed of the procedures and the standard signals. The revised process would lead to decreased conflicts between recreation boaters and commercial tow operators, and between recreation boaters and lock and dam operators. With fewer boats congregating at the locks, the potential for collisions or accidental drifting of boats into the spillway would be reduced. This would be a net benefit to the public safety and would improve the quality of the recreation experience on the river. At some locks in the St. Paul District, however, this alternative is essentially in effect. The lock operators normally monitor the waiting recreation traffic and, at convenient intervals during peak traffic, pass recreation boats. This tends to minimize the inconvenience caused to recreation boaters for the short term.

6.227 On summer weekends and especially on holidays, the recreation boaters are very numerous on the river and waiting periods at the locks as well as traffic pattern conflicts between commercial and recreation boaters, become greatest. Commercial navigation could possibly be restricted on days of especially heavy recreation use. This policy would require an extensive change from present modes of operation. Such restrictions of commercial navigation craft could impose hardships on those craft which are away from the home port or port of destination and would be required to spend time in a river port without proper docking facilities. Economic losses would also be sustained by the commercial craft who would be forced to shut down during such periods, since most commercial craft usually operate on a "round-the-clock" basis. However, there could be reduced safety hazards at the locks due to use of such a policy. Implementation of such a policy would probably be considered only if the previously discussed revision of locking priorities were in full use and judged inadequate to serve the needs.

6.228 With the increased boat traffic expected in the future, structural modification of the locks or provision of a mechanical boat-lifting device might be considered as long-term solutions to the problem of congested boat traffic at the locks. This alternative would entail activation of the auxiliary locks or installation of a device to mechanically lift boats over and across the dam embankment. The utilization of a crane-type lifting device would require that physical contact be made between the recreation craft and the lifting device.

This creates the potential for damage to the craft and for liabilities to the operating agency. The lift device would also require that passengers leave their boat during passage and reboard it following passage which increases the potential for injury on Government property. Because of these and other reasons, development of auxiliary locks may constitute the more practicable long-term solution of the problem of congestion at locks.

6.229 Developing the auxiliary locks could provide for separation of commercial and recreation traffic in addition to providing the lock capacity required to eliminate congestion. Construction of the downstream lock gate and extension of the guidewall, in addition to other structural modifications, would be required to complete the auxiliary lock. The order of priority of development would be based on traffic with the locks having the heaviest traffic being activated first.

6.230 The primarily biological impacts are minor but would include a slight reduction of aquatic vegetation, invertebrates, and fish during the period of construction due to temporarily increased turbidity. There might also be a slight increase in fish mortality due to the increased use of tailwaters open to the lock chamber.

6.231 The primary social impact of the project would be the reduced waiting time and congestion at locks and the increased employment. There would also be a temporary increase in employment and a slight reduction in recreation fishing during construction. The public safety in the vicinity of the locks would also be improved.

6.232 This alternative would have economic benefits over the long-term, as the passage of commercial tows could be made more efficient through the use of an auxiliary lock. The time at which construction of the auxiliary locks would become necessary and justified would depend on the amounts of total river traffic and the relative proportions of commercial to recreation craft. A case-by-case analysis would be required prior to any such construction.

USES OF DREDGED MATERIAL

6.233 The major beneficial uses of dredged material were considered under three general categories:

a. Commercial

b. Recreation

c. Wildlife habitat

6.234 Commercial - Since the current methods of dredged material placement result in direct and indirect impacts on sensitive floodplain forest, marshes, and shallow water areas such as backwater sloughs, commercial use

of the dredged material might provide a more beneficial use of the river sand. The adverse environmental impacts of current dredged spoil placement might be reduced by promotion of other uses of the material in areas less ecologically sensitive.

6.235 Potential commercial uses of the material being dredged in the maintenance of the 9-foot channel within the St. Paul District would consist primarily of the major uses for which sand is currently being used in the area. Major potential uses include:

a. Fill material, such as landfill for development.

b. Aggregate, such as concrete or asphalt aggregate, mortar sand, etc.

c. Miscellaneous, such as for highway sanding of icy roads in winter, etc.

6.236 To be able to utilize the material for commerical uses, many factors must be evaluated with regard to these uses, including physical suitability of material, economic factors, and social and environmental impacts. The dredged material could probably be used either with or without further processing, depending on the particular use for which it would be intended. Potential commercial users of sandy dredged material are located both within and outside of floodplain lands. The major potential users are probably located within floodplain areas, as these areas are the closest to the majority of the dredging locations. Most major potential commercial users of the material would be located at major population or industrial areas, such as Minneapolis, St. Paul, Red Wing, and Winona, Minnesota; LaCrosse and Prairie du Chien, Wisconsin; and Guttenberg, Iowa.

6.237 The dredged material in the St. Paul District is basically sand. The composition and type of material varies throughout the reaches of the Upper Mississippi River and tributaries under consideration, from a silty material near the upstream end of Lake Pepin to a coarse sand near the mouth of the Chippewa River. The material being dredged in the reach of the river from the lower end of pool 4 (below Lake Pepin) through pool 10 appears to be fairly uniform in type, ranging from a coarser sand in the lower end of pool 4 to a finer sand in pool 10, with the material generally tending to be finer as it progresses downstream. Some sample gradations of dredged material from this reach are presented in Exhibit 71.

6.238 The material being dredged between Lake Pepin and lock and dam No. 10 consists of over 60 percent of the material being dredged in the system. The major potential impacts and effects of the various uses include:

a. Reduction in the extent to which aquatic and terrestrial ecosystems would be disrupted adjacent to the main channel of the Mississippi River near dredge cut locations due to future dredging requirements. Practical use of dredged material commercially would require quite different dredged spoil placement practices. As such, many of the adverse impacts associated with current practices could probably be reduced.

b. Use of sandy dredged material commercially might preclude the necessity to take the desired material from other environmentally sensitive locations.

c. An economic return could probably be gained from the sale of such material.

d. Increased costs would be incurred in transporting dredged material to a suitable location to provide access for commercial users. The dredged spoil is being placed at areas normally inaccessible to most potential commercial users of the product. The increased handling costs could be high in dredging locations which are remote from reasonably accessible sites.

e. Increased costs might be incurred in processing the dredged sand to make it suitable for certain commercial uses.

f. Aquatic and terrestrial ecosystems in the areas at which the material would be placed to make it more readily available to commercial users would be disrupted.

g. Promotion of the use of the dredged material in land fill operations could result in potential increased development in floodplain areas. Such development might increase the potential for flood damages. Land which is normally filled for floodplain development is often forest, marsh and aquatic ecosystems. Floodplain fill and development would be subject to the existing laws concerning activities in the floodplain.

h. Economic processes, including the laws of supply and demand, could be disrupted by providing material to areas which do not normally have this material readily available. The economic impact would probably be felt primarily by private dredge contractors and sand and gravel companies which might lose business because of an artificial change in market conditions.

i. Any portion of the dredged material which would be a byproduct of a processing operation might create a disposal problem.

j. There could be a reduction in the amount of future open sand areas available for turtle nesting habitat and recreation beaches, as the normal replenishment would be reduced.

6.239 There appears to be little question that the sandy dredged material has the physical characterisitics of being suitable for several commercial uses. The most suitable use appears to be for land fill. Various communities along the river have expressed a desire for fill material, ranging from small quantities (less than 10,000 cubic yards) to very large quantities (in excess of 500,000 cubic yards). The amount of material and time of delivery desired range from whenever available to specific amounts with a given period of years. The price these communities are willing to pay range from accepting it free of charge to up to about $.25 per cubic yard when placed in a suitable stockpile area. Most land areas for which the fill is desired are the undeveloped low-lying floodplain areas adjacent to currently developed areas. The biological productivity in many of these areas is quite comparable to that of current dredged material disposal areas. In many areas where fill material along the river is desired, the material is obtained by dredging from the closest suitable location, usually from off-channel deposits of sand and gravel and also the sandy bed load of the main river channel. The filling and subsequent development of floodplain lands is not always considered to be a wise land use decision, thus the amount of fill material that can be judiciously used in areas for which a demand is currently indicated is probably limited. The actual amounts of material to be judiciously used in this manner are not known.

6.240 Sandy dredged material has been used in the past for the sanding of icy roads in the winter, and indications are that it is generally suitable for such use, although in some cases it has been felt to be too fine to be effective. Although the demand for such use is not known, it is not estimated to be of major proportions, primarily because of the variability of the demand and the relationship of the roads to the material locations. Topographic relief provides only for a limited mileage of highways paralleling the river, with the majority of other roads leading away from the river. Transporting heavy commodities such as sand up the steep grades from the river valley to the uplands is not normally the most desirable way to provide the sanding material. Long haul distances for such material could be a limiting factor for its use.

6.241 Use of the dredged material in either concrete or asphalt aggregates, mortar sands, or other similar uses would probably require that the material be processed and be mixed with other material, either coarser or finer to provide the necessary gradations. In many sand and gravel operations, the proportion of sand to gravel is such that sand is produced in excess of the demand for it, and the excess sand constitutes a waste product. For sand and gravel deposits to be of practical value for construction purposes, they must contain sufficient tonnage of material with a relatively high ratio of coarse to fine material to warrant erection of a recovery plant. The distribution of sand and gravel in the Upper Mississippi River basin area is such that

deposits can normally be found locally where projections indicate they will be needed. This is especially true in the Mississippi River valley proper. The material dredged, being principally a fine sand, is quite abundant and consequently the general demand is very closely related to the economic cost of obtaining the material.

6.242 For all the uses which have been discussed, and for most sand and gravel uses in general, because of the large bulk volume and low value of the commodity, the transportation costs are a vital economic factor. Thus, although there may be potentially feasible commercial uses for the sandy dredged material, the demand for the material is generally quite limited because of the abundant availability of the material and the economic factors involved. In most cases, the amount an individual community or company would be willing to pay for the dredged spoil would probably not even come close to the extra cost that would be involved in providing it.

6.243 Under current policy and practices, whenever an individual expresses a desire for the material, the material is delivered to him if no extra costs are incurred by the government or regulatory controls are not violated in the process. Such a policy could be expected to continue into the future until such time as either the demand for the material would increase or the material can be justifiably moved greater distances at no cost to the recipient of the material. The Corps of Engineers has the legal capability to sell the dredged material under its contracting procedures. It would be sold to the highest bidder and must constitute a benefit to the government.

2.244 Recreation - Development of dredged spoil areas for recreation is considered in response to the need for finding constructive and beneficial uses of dredge spoil disposal areas which are compatible with the existing environmental setting and in response to the need for eliminating certain adverse effects of the present recreation use of dredge spoil disposal areas.

2.245 Recreation development of dredge disposal areas along the Mississippi River 9-foot channel has a potential for providing a high quality recreation experience in a leisurely and low density recreational use setting. Primitive camp and picnic facility development and associated maintenance and operation activities would eliminate problems of unacceptable sanitation, trash and litter accumulation, and the absence of a drinking water supply which are part of the present setting. This development would also provide for increased recreation use of these areas.

2.246 Recreation developments of two different types could be considered, one of a small degree of development to serve as more primitive camping areas, and one to serve as a larger group type camping area. The primitive sites could serve as camps or picnic areas on approximately 2 1/2 to 5-acre dredge spoil sites or dredge spoil islands, requiring the following

site and facilities: a pit-type toilet (subject to placement above flood profile and conformance to State regulations), a hand-pump water supply, a gravel-filled wastewater drain, trash receptacles, and individual tent sites with about a 15' x 30' level area, picnic table, ground-level fireplace, and inconspicuous shoreline grading for boat landing with a post or anchor for boat tie off. Primitive trails, visitor information board, and other inconspicuous interpretive measures could be included where sites are on or adjacent to larger natural or semi-wild areas. The total cost of each such small primitive recreation site development would be about $30,000 and have an annual operation and maintenance cost of about $1,000.

6.247 Large group camp areas could be provided on 20 to 30-acre dredge spoil sites. Facilities and sites similar to those for the smaller primitive sites could be developed, except that the number of facilities would be greater, vault-type toilets would be used, and other additional facilities could be developed. These additional facilities might include group camp or picnic sites with a group-type shelter (surfaced floor), about a 30' x 100' level area, a large fireplace, picnic tables, inconspicuous shoreline grading for boat landing, and posts or anchors for boat tie-off. A lookout point, trails, visitor information board, interpretive signs and displays, landscape planting, and an interpretive nature trail about a mile long with interpretation measures to concentrate upon special biological relationship of river islands could also be developed. The cost of this type of larger development would be about $100,000, with an annual operation and maintenance cost of about $4,000.

6.248 These recreation developments would require the commitment of either existing spoil sites or future spoil sites to recreation, largely consistent with land use zoning as presently recognized in the master plans for Mississippi River navigation pools. These commitments, however, would not be irretrievable because the proposed development of primitive facilities would require minimal construction and minimal modification of the characteristic topography of dredge spoil sites. Therefore, any future decision to convert the recreation areas to another use such as wildlife habitat or intense recreation could be easily implemented.

6.249 The proposed commitment to recreation would have unavoidable biological impacts in terms of preventing the natural biological colonization and succession on those areas which were developed. However, the landscape plantings associated with the recreation development would have some wildlife value, especially for small mammals and birds.

6.250 The outstanding social impact of this alternative would be the increase in recreation opportunity along the river and the enhancement of the recreation experience. The provision of sanitary facilities and

the improved trash and litter disposal would remove a source of water pollution and improve the aesthetic setting. The sanitary facilities and water supply would have to be constructed consistent with public health codes and State regulations. Special provisions would be needed in areas subject to inundation by high water levels.

6.251 The economic impacts of recreation development would be realized in terms of money expenditures by the recreation users for such needs as food, fuel, sporting goods, boat rentals, etc. Several local part-time summer season jobs would be created in order to provide operation, maintenance, and repair of the site.

6.252 This measure is applicable to the dredge spoil disposal and public relations aspect of the maintenance and operation of the Mississippi River 9-foot navigation channel. The most prominent adverse effects which would be treated include the sanitation and litter problems associated with present practices. Although no definitive recreation demand analysis is available, it is presently estimated that approximately 20 percent of the past and future dredge spoil sites (in terms of surface area) could be committed to recreation development. The areas where recreation development would be of greatest benefit to the recreation-using public would have to be determined on a pool-by-pool basis. Development of these recreation facilities would probably require 50-50 cost-sharing with a non-Federal sponsor and would have to be operated and maintained by non-Federal interests. Development of minimum recreation facilities to protect the public health and safety would be a complete Federal responsibility. Minimum facilities are provided as described in the "Master Plans for Resource Management" for each pool. These master plans are subject to revision and updating as the needs arise. Provision of recreation developments would be dependent on a detailed case-by-case analysis, whereby sufficient recreation benefits would have to be generated to justify the cost of development. In many cases, cost-sharing assurances would also be necessary from non-Federal interests to implement this development.

6.253 Wildlife habitat - Development of dredged spoil areas for wildlife habitat is being considered primarily because habitat availability is a prerequisite for the existence of wildlife, and the presence of wildlife assures continued use of this natural resource on both a consumptive and nonconsumptive basis.

6.254 Dredged spoil sites are in most instances sterile for long periods of time. Continuous coverage of areas with dredged spoil steadily decreases the total percentage of inhabitable area by most species of wildlife. Reducing the percentage loss of wildlife habitat or actually increasing the amount of wildlife habitat available (reclamation) would undoubtedly benefit wildlife.

6.255 Eroding dredge spoil piles affect aquatic habitat principally in terms of loss of depth, increased turbidity, burying of living organisms, and altering the bottom to a relatively sterile sand substrate. For example, the general depth of downstream and lateral non-channel areas is affected by the amount of secondary movements of dredged material. In addition, nutrient cycling and rates of sedimentation are altered by changes in water movement.

6.256 Development of wildlife habitat could be accomplished by judicious use of dredged materials. Variations of dredge spoil utilization and various site development might include the following:

a. A situation may exist where a deficiency of habitat limits the abundance of a particular species which for one reason or another is considered valuable, rare, or endangered. Vegetation on spoil sites could then be manipulated to meet the specific requirements of the species of wildlife in question.

b. Wildlife use might be optimal between a range in sizes of land mass. In terms of nesting success, waterfowl productivity may be most efficient on grass covered islands less than one acre in size. Annual requirements for ruffed grouse and white-tailed deer would be considerably larger. Isolated land masses might even be joined together if land or habitat continuity was desirable.

c. Controlled water levels within a confined diked area would optimize the production of high quality aquatic vegetation or, conversely, the elimination of undesirable plant species. Seasonal utilization by ducks might then be regulated for spring, fall, or any seasonal combination.

d. Modifying wave action or current flow may encourage or discourage aquatic vegetative growth. Islands or elongated areas perpendicular to prevailing winds or current flows could provide more stable conditions for some types of aquatic vegetation.

e. Diked areas delineating refuge boundaries might alleviate problems of trespass in open water areas. Access roads or paths might be desirable for consumptive or nonconsumptive utilization.

f. Depending upon the desirability of particular vegetation types, deep areas might be selected for partial filling.

6.257 Both terrestrial and aquatic wildlife habitat could be enhanced by proper utilization of dredged spoil materials. The quality and quantity of terrestrial habitat is directly dependent on the success of vegetative introduction or reclamation. Aquatic habitat development or enhancement is more indirectly associated as water conditions are more dependent upon the absence of secondary spoil movements such as erosion.

2.258 The quality of terrestrial wildlife habitat depends upon the species of plants utilized for dredged spoil stabilization and their nutritive value. Particular species of plants offer multiple uses to wildlife, such as grasses offering both nesting cover for waterfowl and a seed source for food. Relative density and food value of a plant also depend upon soil fertility and/or availability of nutrients in the substrate.

2.259 A net increase in one type of wildlife habitat will generally result in a decrease of another. The creation of an island, for example, would result in a loss of aquatic habitat of a comparable size. The benefits of one type of habitat as opposed to another are subjective and the relative values of each would differ from one individual to the next.

2.260 Under proper utilization and management of the wildlife resource, gains would occur in terms of environmental and biological considerations. Consumptive and nonconsumptive uses of wildlife will increase with an increase of both the quantity and quality of wildlife habitat. Therefore, increases in value should be realized in terms of aesthetics, most forms of recreational uses, and economics.

2.261 Deposition of dredged materials as a result of present operational and maintenance activities accomplishes very little in terms of creating wildlife habitat. The exception to this is the considerable quantity of nesting habitat for turtles and gently sloping shoreline used by shore birds. Creation of wildlife habitat would tend to offset the annual increase in spoiled acreage. Terrestrial habitat development would also benefit aquatic habitat in terms of reducing secondary movements of dredged materials. Provision of such habitat development would be dependent primarily on the ability to grow plants on the dredged spoil, as discussed in the Revegetation alternative measure. The availability of funds to provide such habitat would also be necessary.

ALTERNATIVE PLANS

2.262 In an effort to provide a better illustration and understanding of the general relationship of some of the alternative measure approaches to operation and maintenance activities of the 9-foot navigation channel, several alternative plans were evaluated for each navigation pool. There are a multitude of possible combinations of the alternative measures, each combination with its own specific impacts and effects. The alternative plans evaluated here are only to be considered as representative of several possible alternative measure combinations.

2.263 The alternative measures selected for inclusion in the alternative plans are not to be considered as the only nor the best alternatives which will alleviate adverse impacts of the existing operations and maintenance activities. In several pools, for example, a measure such as dredging

openings into backwater areas may be best suited for alleviation of particular adverse impacts. However, because of the rather limited suitability and the need for additional study to properly assess the effects and impacts of several measures, only those which had the most widespread and general applications were selected for evaluation in the alternative plans. These alternative plans were selected on their estimated ability to reduce the adverse impacts of the present activities, primarily those associated with the long-term placement of dredged spoil. Although these plans may reduce present adverse impacts, several plans may actually create other adverse impacts which would completely offset any potential gains of the plan. The alternative plans were evaluated based on alternative placement procedures and locations, any necessary increases in dredge plant capability, revegetation of dredge spoil areas for either soil stabilization or wildlife habitat development, and recreational developments on the sandy dredge spoil areas. Each of these measures were utilized to varying degrees under alternative plans.

6.264 The data used for estimates of projected future dredge spoil requirements over the next 50 years was based on the dredging done over the 17 year period from 1956 to 1972 as shown in Exhibit 56. This period was felt to be somewhat representative of possible future dredging needs, however, several factors such as major flood flows and changes in land use practices or channel alignments could substantially change dredging needs. In some instances, such as the Minnesota River, and Upper and Lower St. Anthony Falls, a shorter base period was used as noted for the individual pool. The area requirements for the dredged spoil sites were based on using unconfined disposal conditions with a one vertical on ten horizontal side slope and a maximum height of spoil area of 30 feet. When an area over about 10 acres would be required in one location, a general height of dredged spoil of 30 feet would be assumed. Disposal techniques in an area would be accomplished to provide the minimum amount of area disturbed by dredge spoil at any given time.

6.265 The dredge spoil sites for each alternative plan were selected using an interdisciplinary approach, recognizing the many complex features of the river environment. Such factors as the value of the aquatic and terrestrial habitat types, the physical feasibility of moving dredged spoil to the final disposal site, and the relative values of an area for recreational development were all considered in making the site selections. Additionally, the disposal site selection and final utilization were selected with an effort to alleviate the majority of adverse impacts of the present operation and maintenance activites and to provide the maximum beneficial use of the material. The costs associated with each plan were not evaluated in light of whether or not such a plan would be justified or even desirable.

6.266 Most sandy dredge spoil areas were planned for either revegetation, development for recreation, or left as sandy beach areas to provide informal overflow recreation areas. Recreation demand for developed facilities was

assumed to exist for each pool, ranging from about 20 to 70 acres depending on the location and recreational use potential of the area. Recreational developments were located on either existing or future spoil areas depending on their potential value. Dredged spoil sites located in high value wildlife areas were estimated to be developed for wildlife habitat. Although the exact types of vegetation that could actually be grown on the dredge spoil areas are not known, it was assumed that vegetation similar to that which currently grows in the area could be grown if appropriate measures were taken. The value of these areas as wildlife habitat was assumed to be similar to that which currently exists after taking into account an appropriate time for establishment. Utilizing the procedures described in the alternative measure of revegetation, the gradual conversion of a sandy dredge spoil area to a vegetated area that would provide valuable wildlife habitat would take several years and in the interim, there would be temporary losses of wildlife habitat value. The final value of a revegetated dredge spoil area to wildlife could be less or greater than the original habitat, depending on the habitat provided and the diversity of the surrounding habitat. The major impacts and effects of the alternative plans were evaluated using those parameters which would most likely be affected. An explanation of the impact and effect parameters used for evaluation is listed in Exhibit 194.

2.267 The economic parameters evaluated were primarily the first costs and annual costs of implementing the plan. These costs included the necessary dredging equipment (both permanent and portable), recreation development, and revegetation as previously described in the respective alternative measure discussion. For long distance pumping of dredged material, the lower pumping rate of about 12 feet per second was used in the evaluation. This lower rate of pumping would require the dredging in the Rock Island District to be accomplished by contract dredging. The additional cost incurred by the contract dredging is also included in the cost evaluations. The average annual costs were based on a fifty year economic life and were amortized at a 6-7/8 percent interest rate. Costs for annual operation, maintenance, and replacement were also included. In the individual pool evaluations the floating dredging equipment needed was assumed to be used throughout the St. Paul District and the annual cost of this equipment was assumed to be allocated throughout the district in proportion to the volume of material dredged. The annual costs of the additional permanent dredging equipment and associated facilities needed within a particular pool as well as the revegetation and recreation development were added to the allocated costs of the floating dredge equipment to give the total average annual cost for each pool. This total annual cost for the pool was then divided by the average annual volume of material dredged for that pool to provide an estimated cost per cubic yard of the material dredged.

6.268 The social well-being parameters were evaluated in a general manner taking into account how several major parameters might be affected by implementing the various alternative plans. Recreation opportunities, employment and public health and safety were the most often affected parameters. The effect of the impact was indicated in terms of a general increase or decrease, or as no significant change.

6.269 The land use effects were evaluated on the acreages of increase or decrease to a particular land use category as a direct result of dredge spoil placement, revegetation, or recreation development. These land use conversions were estimated on net change over the next fifty years.

6.270 The impacts on the natural environment were based on the net acreage changes in aquatic and terrestrial habitat types as a direct result of the dredging, revegetation and recreation development over the next fifty years. The relative effects on aquatic and terrestrial animals were based primarily on the basic changes estimated for the habitat types. The dredged spoil deposits were classified as open sand areas, recognizing however, that depending on specific conditions at each individual spoil area varying degrees of natural revegetation would occur.

6.271 The major plans which were evaluated for most pools were the following:

a. Status quo

b. Selective placement

c. Remote disposal

d. Central disposal

e. Remove from the floodplain

6.272 Although these plans have the same titles as the alternative measures for placement of dredged materials and consist of the basic measure as therein described, the plans also include other measures to provide additional capabilities for alleviation of adverse impacts. The major features used in the evaluation and development of each plan are briefly discussed.

STATUS QUO

6.273 The existing operation and maintenance activities would be carried out in the future as they have been in the past. There would be limited increases in dredge plant capability, only enough to place the material off to the side of the navigation channel. No major revegetation efforts would be attempted on spoil areas and only recreational developments comparable to that done in the past would be developed. The open sand areas would be available for informal recreation areas. Adverse environmental impacts would be similar to those under present conditions, although several impacts, such as decreased flow to backwater areas may be even more pronounced. Other improvements and activities, including coordination with other interests would continue as in the past.

SELECTIVE PLACEMENT

6.274 The number of disposal sites would be reduced and fewer sites would be selected, usually within a total pumping distance of 1 to 2 miles of the dredge cut locations. Planned development of the future dredge disposal sites would be included for revegetation or recreation. Old spoil sites would be similarly treated. The major adverse environmental impacts of the existing activities would be reduced, although aquatic habitat would continue to be reduced in acreage.

REMOTE DISPOSAL

6.275 The number of disposal sites per pool would be reduced to as few as possible, keeping the dredge plant pumping distance to normally less than 5 miles. Special dredging facilities would have to be provided in several locations, such as construction of permanent shore facilities or dredging backwater channels to provide access to the disposal sites. Final utilization of the dredge spoil areas would be done in a manner compatible with the surrounding environmental setting.

CENTRAL DISPOSAL

6.276 Only one disposal site per pool would be used for future dredged material (except for pool 4, where two areas were designated, one above Lake Pepin and one below). As with remote disposal, special dredging facilities would have to be provided. Similar treatment would be given to the disposal sites as under selective placement and remote disposal.

REMOVE FROM FLOODPLAIN

6.277 Stockpile areas at the edge of the floodplain would be selected to allow the dredged material to be transported out of the floodplain by other methods, i.e., railroad, truck, or barge. The costs and impacts of placing the material in the stockpile areas were estimated. Specific facilities necessary and actual costs of removal from the stockpile area were not evaluated on a pool-by-pool basis. For this evaluation, it was assumed that the mode of transportation from the stockpile area would be by truck and that there would be a suitable disposal site out of the floodplain within about 25 miles of the stockpile area. Any extra costs or facilities that would have to be developed at either the stockpile or disposal area were assumed to be included in the unit price of moving the material. It should be recognized that to fully evaluate this plan, suitable disposal areas and the specific extra facilities required at each location would have to be determined in more detail and as such, costs of removal from particular stockpile areas may vary from those estimated. It was assumed that the material could be used in a non-floodplain area and consequently removed from the stockpile area on a regular basis. The existing spoil areas would receive treatment similar to that described for selective placement.

ALTERNATIVES FOR INDIVIDUAL POOLS

6.278 The most pertinent and important aspects of each navigation pool and the relationship to future operation and maintenance activities of the navigation channel are discussed on a pool-by-pool basis. Those alternative measures which offer the greatest potential for reduction of adverse environmental impacts of the present operation and maintenance activities, the major reasons for their selection, and the potential impacts and effects of implementation are presented in the discussion section for that pool. These alternative measures were selected based only on their potential for alleviation of adverse impacts and are not recommended for implementation. Often the added cost of implementing the measures could far exceed any benefit to be gained. The actual viability of several measures is not truly known, and actual costs and other effects may be different from those presented here, especially on an individual case basis. The true value of these alternative measures in alleviating adverse impacts of the present operation and maintenance activities would depend on a more detailed case-by-case evaluation.

6.279 In addition to the presentation of alternative measures which offer the greatest potential for alleviation of adverse impacts, alternative plans for handling future dredge spoil within each pool were also evaluated. Although several of these alternative plans may seem out of line and obviously unreasonable to many individuals, they are presented as objectively as possible so that each alternative may be judged on its own merits and conclusions concerning the alternative plans may be reached on an individual basis.

6.280 The effects and impacts of the alternative plans were evaluated based on the next 50-year period and the general features of plan implementation as previously described. The areas selected for disposal, the acreages required, and the effects and impacts described were based on the existing and probable future physical settings within each pool. The effects and impacts of implementing these alternative plans for the individual pools are tabulated in Exhibits 195 to 208. The size and location of the dredge spoil areas upon which these evaluations were based are listed in Exhibits 209 to 222.

UPPER AND LOWER ST. ANTHONY FALLS

6.281 The most prominent aspect of the area adjacent to the Upper and Lower St. Anthony Falls pools is that it is highly urbanized, including large industrial and commercial areas. The material being dredged from the pools is located primarily at the upper end, about river mile 857, near the Riverside Power Plant. The river valley is extremely narrow through this reach with very steep banks. There is little floodplain land available for dredged material disposal and most disposal is done in open water and then sidecast along shore. During major flood flows apparently some and possibly a substantial portion of this material is returned to the main channel for redredging. Depending on the quantity of bedload material

actually returned to the channel, the effectiveness of alternatives to present operation and maintenance activities could vary greatly. For purposes of the alternatives evaluation, little of the material is considered to be returned to the main channel requiring redredging, and the volumes of material to be dredged in the future are estimated to be similar to what has occurred since construction of the Upper St. Anthony Falls lock (about 1964).

6.282 Alternative measures - Those alternative measures which offer the greatest potential for reduction of adverse impacts in the Upper and Lower St. Anthony Falls pools include remote disposal, remove from floodplain, and commercial uses.

a. Remote disposal - Continued placement of dredged material within the St. Anthony Falls pools would not be a sound long term approach to the disposal problem. Areas currently being used are not capable of being used for many years in the future and additional areas will become increasingly difficult to find. To plan for placement of dredge spoil in a floodplain area, the closest area for suitable disposal would be located in the Minnesota River floodplain, about 14 miles away along the navigation channel. About 60 acres would be required for a disposal area. Placement of the material in the Minnesota River floodplain would cost much more than the present dredging costs, but the opportunity for a more beneficial use would be available. Continued placement within the narrow confines of the St. Anthony Falls pool area would tend to restrict the floodplain and allow more material to be eroded back into the channel.

b. Remove from the floodplain - As mentioned in connection with the remote disposal alternative, suitable space in the floodplain is very limited. Creation of stockpile areas from which the material could be removed would solve the disposal site location problem. Dredging costs might increase slightly because of a slight modification to the disposal area, however, access to the stockpile areas for removal would probably be necessary. Loading and transportation of the material from the stockpile area would be an added cost. This extra cost would vary depending on the use for which the material is suitable and on how far it would have to be moved from the stockpile area.

c. Commercial use - The location of the pools in the "heart" of an industrialized urban area should offer the greatest potential for a suitable commercial use of the material. The potential use for either land fill or street sanding appear to be among the most feasible. The Minneapolis Public Works Department has indicated that it might be able to use the material as backfill for street excavation and as possible fill on new road construction. The cost and availability of the material would be critical items affecting their desire for the material. They could probably use most of the material that is being dredged annually from the Upper and Lower pools. The cost, availability, and suitability would be key factors for any potential user.

6.283 Alternative plans - The possible alternative plans for evaluation were limited to status quo, remote disposal, and remove from the floodplain, because of special circumstances of the Upper and Lower St. Anthony Falls pools. Evaluation of the selective placement and central disposal plans would be similar to status quo and remote disposal, respectively. Exhibits 195 and 209 illustrate the effects and impacts, and disposal area requirements of the alternative plans.

a. Status quo - Continuation of existing operation and maintenance activities would require designation of two disposal areas for future dredged spoil totaling about 40 acres. Approximately 30 acres would have to be deposited on existing spoil areas while 10 acres of channel border would be lost. Impacts and effects would be quite similar in the future as they have been in the past. The major impacts would be on the restriction of the river channel and the probable erosion of dredge material back into the river channel. Average annual costs would be approximately $70,000.

b. Remote disposal - Remote disposal of the material in a floodplain area could probably best be accomplished in the Minnesota River area. Development and utilization of the material for fill in the Minnesota River floodplain would depend primarily on the suitability of such use. A 60-acre site would be required which would be subject to alteration depending on the final designated use of the disposal area. The cost of moving the material to this area would be greater than present costs. Use of a derrickbarge operation would probably be required for dredging and a barge for transportation of the material to the disposal area. Earth moving equipment would probably be required to move the material to its final placement. Average annual costs would be approximately $275,000.

c. Remove from floodplain - A 10-acre stockpile area might be provided in the upstream portion of the Upper St. Anthony pool from which the material could be removed. Access and loading facilities would be required. The major costs involved would be in removal of the material from the stockpile area to the final use site. Any funds received for the material as it exists in the stockpile area could be classified as a benefit to help offset the cost of dredging. The average annual cost would exceed $250,000.

POOL 1

6.284 The most prominent aspect of the area adjacent to pool 1 is that it is highly urbanized, being mostly a residential area, with a greenbelt, open space corridor flanking the river on both sides, throughout the length of the pool.

6.285 The river valley is extremely narrow through this reach with very steep banks. There is little floodplain land available for dredged material disposal and most disposal is done in open water and then

sidecast along shore. During major flood flows, apparently some and possibly a substantial portion of this material is returned to the main channel for redredging. Depending on the quantity of bedload material actually being returned to the channel, the effectiveness of alternatives to present operation and maintenance activities could vary greatly. For purposes of the alternatives evaluation, very little of the material is considered to be returned to the main channel requiring redredging, and the volumes of material to be dredged in the future are estimated to be similar to what has occurred during the period 1956-1972.

6.286 Alternative measures - Alternative measures which offer the greatest potential for reduction of adverse environmental impacts in pool 1 include remote disposal, remove from floodplain, commercial uses, and development of recreation beaches.

a. Remote disposal - Continued placement of dredged material within pool 1 would not be a long term approach to the disposal problem. Areas currently being used are not capable of use for many more years. Additional areas will become increasingly difficult to utilize because of the high demand for open space and natural areas. To handle the dredge spoil in a floodplain area, the closest area for suitable disposal would be located in the Minnesota River floodplain, about 10 miles away along the navigation channel. About 150 acres would be required for a disposal area. Placement of the material in the Minnesota River floodplain would cost more than the present dredging costs, however, the opportunity for a more beneficial use would be available. Continued placement within the narrow confines of the pool 1 area would only tend to restrict the floodplain and allow more material to be eroded back into the channel.

b. Remove from the floodplain - As with the considerations discussed in the remote disposal alternative, space in the floodplain is limited in this area. Creation of stockpile areas from which the material could be removed from the floodplain would solve the disposal site location problem. Dredging costs might increase because of modifications to the disposal area, however, provision of access to the stockpile area for removal would probably be necessary. Loading and transportation of the material from the stockpile area would be an added cost. This extra cost would vary depending on the use for which the material is suitable and upon how far it would have to be moved from the stockpile area. Use of a stockpile area in pool 1 would have to be weighed against the time and expense involved in going through the locks if the material were to be removed from pool 1. Stockpile use would, however, tend to conflict with the open space concept as zoned for the area.

c. Commercial use - The location of the pool in the "heart" of an urban area should offer the great potential for a suitable commercial

use of the material. The potential use for either land fill or street sanding appear to be among the most feasible uses. The Minneapolis Public Works Department has indicated that it might be able to use the material as backfill for street excavation and as possible fill on new road construction. The cost of the material and zoning restrictions for the area would be important items affecting the availability of the material. They could probably use some of the material that is being dredged annually from the pool 1. Other potential users may also exist, but none have been identified at this time. The cost, availability, and suitability, would be key factors for any potential user.

d. Recreation beaches - The dredge spoil that is placed along shores of pool 1 offers a potential as a recreation beach area for camping and general riverside recreation. Even though the water quality is not considered of excellent suitability for water contact, it apparently is utilized for general recreation. The zoning of the river corridor as open space areas makes such use even more desirable. It is doubtful that all future dredged spoil could be beneficially used in such a manner, however, material that is placed there could be developed or at least utilized for such purposes.

6.287 Alternative plans - The possible alternative plans for evaluation were limited to status quo, remote disposal, and remove from floodplain, because of special circumstances of pool 1. Evaluation of the selective placement and central disposal plans would be similar to status quo and remote disposal, respectively. Exhibits 196 and 210 illustrate the effects and impacts and disposal area requirements of the alternative plans.

a. Status quo - Continuation of existing operation and maintenance activities could require designation of about a 200-foot wide strip along each riverbank almost the entire length of the pool as disposal areas for future dredged spoil totaling about 200 acres. Future impacts and effects would be similar to what they have been in the past. The major impacts would be on the restriction of the river channel and the probable erosion of the dredge material back into the river channel. Average annual costs would be approximately $131,000. The comparatively high cost for status quo is associated with the large amount of derrick-barge use.

b. Remote disposal - Remote disposal of the material in a floodplain area could probably best be accomplished as previously mentioned, in the Minnesota River area. Development and utilization of the material for fill in Minnesota River floodplain would depend primarily on the suitability of such use. About a 150-acre site would be required and these 150 acres would be subject to alteration depending on the final designated use of the disposal area. The cost of moving the material to this area would be greater than present costs. Use of a derrickbarge operation would probably be required to move the material to its final placement. Average annual costs to implement this alternative plan could exceed $420,000.

c. Remove from floodplain - About a 10-acre stockpile area might be provided in the upstream portion of pool 1 from which the material could be removed. Access and loading facilities would be required. The major extra costs involved would be in the removal of the material from the stockpile area to the final disposal area. Any funds received for the material could be classified as a benefit to help offset the cost of dredging. Such a stockpile operation might create aesthetic conflicts with the open space zoning for the area. The major costs would involve purchase of additional discharge pipe. Average annual costs for purchasing additional equipment and revegetating certain areas could exceed $540,000.

MINNESOTA RIVER

6.288 The aspects of the Minnesota River which were considered pertinent to future operation and maintenance activities of the 9-foot navigation channel include the industrial activity along the river, the open space desires and needs of the surrounding metropolitan area, the relatively low flows of the Minnesota River as compared to the Mississippi River, and small particle size characteristics of the bedload.

6.289 Alternative measures - The alternative measures which offer the most potential for reduction of any adverse impacts associated with operation and maintenance activities include watershed land treatment, revegetation of disposal areas, selective placement, remote disposal, type of dredge, and development of spoil areas for wildlife habitat.

a. Watershed land treatment - The sediment load carried by the Minnesota River is primarily silt, clay, and sand, of a much finer particle size than carried by the Mississippi River or its downstream tributaries. Proper implementation of upstream watershed treatment measures could reduce the amount of fines being carried in the river and probably reduce the amount of material requiring dredging. Although reduction of the fines being carried in the system might help reduce the sediments requiring dredging, the riverbank erosion might increase due to the capacity of the stream to handle more sediment. Watershed treatment would have its primary beneficial effects in the upland areas at the source of treatment and in the large floodplain lakes, such as Spring Lake.

b. Revegetation of disposal areas - The finer, more silty nature of the sediments being dredged from the Minnesota River offer a greater potential for growing vegetation. Utilization of vegetation as a soil stabilizer could be beneficial, as the finer nature of this material makes it more susceptible to erosion from floodwaters and from rain and wind. The relatively high population density of the surrounding suburban areas and nearby urban area place a high demand on scenic river corridors. Exposed areas of silty dredged material do not lend themselves well to integration with a scenic river corridor. Revegetation of the disposal areas would improve the aesthetics and provide wildlife habitat. Reduction in the amount of silty material being moved downstream might tend to reduce the adverse impacts of turbidity and the covering of bottom benthos.

c. Selective placement - Use of selective placement practices could assist in alleviation of adverse impacts by planning an ultimate beneficial use for the areas. Placement of the fine material in open water areas or adjacent to the narrow main channel of the Minnesota River allows for movement of dredged spoil back into the main channel. Selective placement in several on-land disposal areas slightly off the channel would reduce the impacts of the material moving back into the river and allow better use of the spoil area. As the suburban areas become more developed, disposal areas will be harder to find and planned use of these areas will become much more important.

d. Remote disposal - For similar reasons as under selective placement, the use of planned and coordinated disposal areas will be much more important in the future. Use of fewer disposal areas at more remote locations from the river channel and dredge cut locations could be very desirable as the area required could be reduced and permit more latitude in selecting disposal areas. The costs associated with remote disposal need not necessarily increase, as using a hydraulic dredge would allow placement of the material at much greater distances from the channel with probable reductions in costs.

e. Type of dredge - The DERRICKBARGE HAUSER is used for Corps of Engineers operation and maintenance on the Minnesota River. The higher unit cost of handling the material with the derrickbarge, the limited distance it can place the material from the channel, and the high amounts of turbidity created in both the dredge cut location and disposal areas are several major disadvantages in using the derrickbarge. One of the primary reasons for its use is the critical nature of the dredging requirements. Due to lack of manpower, sounding surveys are not run as often as would be desirable, thus when some of the shoal areas reach a depth that interferes with navigation, a boater or commercial shipper reports the condition and the dredge is sent to the scene within several days. Time is of a critical nature, as even short term closures of the navigation channel could create problems with the local and possibly regional economy. Contracting procedures to engage private dredge firms is often a long process, so the most expedient way to accomplish the job is with the derrickbarge. The majority of private dredging done along the Minnesota River is accomplished by small hydraulic dredges. The use of the hydraulic dredge is less costly. The material can be moved farther away from the channel and causes fewer turbidity problems in the dredge cut location although the turbidity in the disposal area would probably be increased. The finer material dredged from the Minnesota River would tend to stay suspended in the dredged slurry for a longer period. Due to the narrow confines of the channel, the DREDGE THOMPSON would not be suited for dredging this portion of the navigation channel. The additional flexibility in placement of the dredged material at greater distances from the channel as well as the decreased costs of dredging would be major factors in using a hydraulic dredge. The hydraulic dredge would have to be capable of moving to the dredge cut on short

notice which might require purchase of an additional dredge by the Corps of Engineers or special arrangements with a private dredging firm using the appropriate Government contracting procedures.

f. Wildlife habitat - Development of dredged spoil areas to provide habitat for wildlife would be desirable along the Minnesota River. As discussed under the revegetation of spoil areas, the scenic beauty of the natural river corridor will probably be more important in the future and provision of additional habitat areas for wildlife would be a necessary feature.

6.290 Alternative plans - The discussion of possible alternative plans for handling the dredge spoil material is extremely speculative along the Minnesota River based on Corps of Engineers operation and maintenance dredging records. Dredging by private interests along the Minnesota River has been much more extensive than the dredging done by the Corps. Access to private dredging information is not readily available and no estimate of their activity has been gathered. Current Corps' records indicate that there are two major dredging locations, one at river mile 0.2 at the confluence of the Minnesota and Mississippi Rivers and the other at river mile 12. The relative impacts and effects of alternative plans for the Minnesota River are presented in Exhibit 197. Estimates of acreage and location requirements for these alternative plans are shown in Exhibit 211.

a. Status quo - Continuation of existing operation and maintenance practices would probably require about four areas of dredge disposal, totaling about 60 acres. As under existing conditions, the material could be placed in areas adjacent to the channel and then would require final placement by use of a small dozer. Since no further work would be done to the areas, unless private interests or State or city governments would come in to reclaim the dredge spoil areas, they would be subject to the same impacts as are presently taking place. Average annual costs for continued operation and maintenance within the guidelines of this alternative plan could be approximately $47,000.

b. Selective placement - Using selective placement techniques, three areas for spoil disposal could be selected and utilized for wildlife habitat. A total of about 55 acres would probably be needed for spoil with no long term major changes in land use or habitat classifications expected. As the sites are filled, some increased demand upon the areas for commercial or industrial sites might be expected. Although increased costs to implement this alternative would not be excessive, the future availability of land for location of the disposal areas could be a limiting factor. The average annual costs could exceed $93,000.

c. Remote disposal - Use of two remote disposal areas would require a total of about 50 acres. Development of these areas could be for either wildlife habitat or commercial and industrial uses, depending on the future demand for business growth. A probable increase in dredging and material handling costs would be necessary because of the longer distance from the dredge cut areas to the disposal area, up to about 3 miles. The average annual cost, primarily for increased plant capability, could exceed $100,000.

d. Central disposal - Use of a central area could require material handling distances of up to 7 miles. An area of about 45 acres would be necessary. Cost increases would be likely and could be in excess of $160,000 on an average annual basis.

e. Remove from floodplain - Two stockpile areas for removal of the dredged material from the floodplain could be utilized. A total of about 10 acres would be necessary at these sites. The placement and removal activities would tend to keep the site continually disrupted, and few benefits to wildlife would accrue at these locations. Material moving distances would probably be up to about 3 to 4 miles. The demand for this finer silty material is not likely to be high, except possibly as fill in floodplain areas within the Minnesota River valley. The major annual cost could exceed $250,000 per year. The major portion of the costs would involve equipment purchase for the necessary increase in plant capability.

POOL 2

6.291 One of the unique characteristics of pool 2 is that more than one-half of the pool is located within an intensely developed area, Minneapolis-St. Paul, and suburbs. The Mississippi River enters the metropolitan area flowing in a southerly direction until it is joined by the Minnesota River at Pike Island. Thereafter, it flows northeastward making another loop in the center of the St. Paul area and then returns to its southerly flow near Pig's Eye Lake. Three large backwater lakes are located within pool 2 and include Pig's Eye, Baldwin, and Spring Lake. High concentrations of secondary treated sewage enter the river at various locations along the upper one-half of the pool. Water quality is such that recreational use of the water in terms of hunting, fishing, and swimming is limited. However, the recreational use of the floodplain forest is high when adequate land-based access is available. Industrial and commercial use of the pool is probably higher than any other pool in the St. Paul District. Individual alternative measures which appear most applicable to pool 2 are presented in the following section.

6.292 <u>Alternative measures</u> -

a. Revegetation - Revegetation of dredged spoil materials is important principally due to its function in stabilizing spoil areas. In pool 2, few of the dredge cuts are located in areas where wildlife species could be particularly benefited due to the general low water quality and disturbance attributable to heavy barge traffic and commercialization of a large proportion of its shores. An exception to this might be near the upper end of Spring Lake where waterfowl nesting might be encouraged if the dredged spoil material was planted with grassland types for waterfowl nesting. Probably more important would be revegetation in terms of aesthetic considerations. Disposal sites occurring on or near highly used parks might be revegetated to enhance the naturalness of the area.

b. Selective placement - Selective placement of the dredged material could be accomplished with a moderate increase of plant capability. Location of sites could be complicated by the constriction of the river valley in certain areas. For example, within the downtown area of St. Paul virtually no on-land disposal is possible and dredging operations are restricted primarily to the HAUSER. The HAUSER fills a barge which is then transported downstream and dumped in open water. An exception to open water dumping occurs in the vicinity of Holman Field. Dredged material is placed immediately below the airfield. The Metropolitan Airport Commission has indicated that airfield and runway extension is anticipated and they would undoubtedly take all available dredged material for several years to come.

Selective placement could offer the advantage of relieving areas already spoiled upon and which have exceeded their capability in terms of containing the material. In addition, less environmentally sensitive areas could be selected for future deposition of materials.

c. Removal from floodplain - Four locations distributed somewhat evenly through the pool could be designated as locations for stockpiling areas. All of the areas offer accessibility to combinations of barge, railroad, or truck transportation. The potential for commercial use of the dredged material is higher in pool 2 than any other pool in the St. Paul District. Because of the restrictions on selection of disposal sites and economic considerations, it is possible that a permanently constructed storage and removal facility might be advantageous.

d. Commercial commodity - The proximity of the metropolitan area to pool 2 offers a great potential for use of the dredged materials as a commercial commodity. Principal types of use could be as fill material, in combination with a commercial aggregate for construction

material, winter sanding of streets, or a variety of recreational uses such as beaches or playgrounds. Swimming beach replenishment or creation along the river is probably not desirable, especially near or downstream of the sewage disposal plant at river mile 836.2. However, use of the sandy material along the river may enhance activities such as hiking. Extensive areas above and below the metropolitan area offer scenic woodlands, rocky cliffs, and a variety of wildlife species.

6.293 Alternative plans - Pool 2 has distinct features which make one or more of the proposed alternative plans more likely to be applicable. The applicability could vary, however, with the validity of certain alternative measures. For example, removal from the floodplain could be more applicable if a commercial commodity demand existed in the metropolitan area, and less applicable if none existed. The general impacts of the plans and the locations of disposal sites selected for each alternative plan are presented in Exhibits 198 and 212, respectively. Aspects and discussions of each plan as it applies to pool 2 are presented in the following sections.

a. Status quo - Status quo could contribute an additional 265 acres of dredge material to the already existing spoil areas within pool 2. Little or no increase in plant capability would be required. The principal loss of habitat types could occur among floodplain forest types. Spoil placement would probably continue below Holman Field and on the opposite side of the main channel from the major flow opening into Spring Lake. Spoil has been placed on Pike Island in the past to allow the "Showboat" to utilize the area. However, since Pike Island is part of the State Park system, no future dredge spoil is expected to be placed there unless by request of the State. Average annual costs are estimated at about $89,000.

b. Selective placement - An estimated 225 acres at seven locations could be required in pool 2 over the next 50 years for placement of dredged material. Plant capability increase would require approximately 11,000 feet of floating discharge pipe with booster pumps located at required intervals if all materials were hydraulically dredged. Aquatic habitat loss could occur in one location at the head of Spring Lake where an estimated 25 acres might be affected and at river mile 819 where 20 acres of a presently submerged stump field could be lost. Adequate revegetation of old and new spoil areas for stabilization and incidental wildlife enhancement could result in a loss of 65 acres of spoil area and provide a substantial increase in grassland types of habitat. Grassland habitat could offer improved waterfowl nesting habitat in the vicinity of Spring Lake. The average annual cost for this alternative plan could exceed $300,000.

c. Remote disposal - Remote disposal could require an additional three locations for spoil disposal and add an estimated increase in area of 205 acres. If hydraulic dredging was employed to dredge all

the material 2 1/2 to 9 miles of dredge plant capability would be required. The estimate is variable due to the flexibility in the number of sites selected. Continued utilization of the clamshell type of dredge could also substantially reduce the required increase in dredge plant capability. Principal aquatic habitat loss could occur at the upper end of Spring Lake where an estimated 35 acres could be affected. Requirements in terms of increased cost for additional plant capability could exceed $580,000 on an average annual basis.

d. Central disposal - A single site of 160 acres could be selected on (Upper) Grey Cloud Island. The amount of dredge plant capability increase could be limited to approximately 10 miles if material from several of the dredge cuts were rehandled. Navigation hazards and the difficulty of handling this amount of floating discharge pipe are obvious. Principal types of habitat loss could occur among the floodplain forest and backwater lakes. Average annual costs for increased plant capability and a combination of recreational development and revegetation could exceed $1,350,000.

e. Removal from floodplain - Three sites of 10 acres each could be selected for this alternative within pool 2 for stockpiling prior to removal. Generally the locations of the sites are evenly distributed along the river. Plant capability would have to be increased to approximately 5 miles if the material was hydraulically dredged and transported from all dredge cuts within the pool to these sites. Two sites within the upper one-half of the pool could offer access to rail, barge, or truck transportation while the sites within the lower one-half of the pool could have access by only barge and rail. No substantial loss of habitat types would occur and the location of the stockpiling areas would not appear to threaten environmentally sensitive or valuable areas. The average annual costs could exceed $785,000.

ST. CROIX RIVER

6.294 The St. Croix River pool receives relatively little dredging activity when compared to other pools along the 9-foot channel system. Approximately 43,000 cubic yards are removed on an average annual basis. Plans for dredged material placement within the guidelines of new alternatives are especially complicated by the steep slopes of the narrow valley in which the river is contained. Characteristics for which specific alternative measures might have definite merit are as follows:

6.295 <u>Alternative measures</u> -

a. Revegetation - Control of the secondary movement of material from dredged spoil areas by revegetation could be important in reducing the adverse impacts of such material movement upon a relatively rare mollusk. A remnant population of the once common mollusk (<u>Lampsilis higginsi</u>) is reported to exist in the Hudson, Wisconsin area.

b. Selective placement - Selective placement of dredged material could be accomplished with little or no extended plant capacity. Consideration of sites for future deposition could take into account minimum possibilities of erosion and yet provide a maximum potential for recreational activities. This should also include consideration of impacts on the rare mollusk mentioned above.

c. Removal from floodplain - Potential markets or uses for the dredged materials from the St. Croix River could probably exist within a practical distance. Sites at which the dredged material could be stockpiled and subsequently removed from the floodplain are reasonably close to major heavy dredging areas. In addition, potential sites are numerous and accessible by either rail, barge, or truck. The material could be placed in these areas with little or no increase in existing dredge plant capability.

d. Commercial use of material - Dredged materials from Lake St. Croix could be used for fill material, sanding streets, possibly as an aggregate, and as beach materials. Local use could occur due to the close proximity of urban areas such as Stillwater and Hudson. Access to St. Paul or Minneapolis is facilitated by an ample supply of railroad connections between the area and St. Paul-Minneapolis. The distance to the Twin City area is small enough to consider that barge and truck traffic might be feasible.

e. Development of recreational beaches - Utilization of the lower reach of the St. Croix River for recreation is high. The river water is of relatively high quality and the area is in close proximity to local urban areas and within easy driving distance from St. Paul-Minneapolis. Therefore, recreational beaches for swimming and camping are in great demand and heavily utilized. Replenishment of older sand beaches and the creation of new areas would probably increase or enhance their use. The demand for dredged spoil for beach use by private individuals has been high in all dredging locations in the St. Croix pool.

6.296 Alternative plans - Amounts of dredged materials could be located at various sites along the St. Croix River dependent upon site suitability and the particular alternative plan of disposal under consideration. The impacts and effects of the plans and the amounts and locations of disposal sites are presented in Exhibits 199 and 214, respectively. The alternative plans are discussed as follows:

a. Status quo - An additional 75 acres of open sandy areas would be added to the already existing sites. No increase in plant capability would be required. Aquatic habitat loss would occur only along the main channel. Recreational use of the areas near Hudson, Wisconsin, and at the delta of the Kinnickinnic River would probably be increased.

Two of the three existing dredge spoil locations along the St. Croix River might be expected to cause potential problems. At river

mile 5.5 the delta of the Kinnickinnic River would be substantially increased outward into the river or, at the very least, elongated parallel to the navigation channel and widened. It could be expected that a safety hazard might develop in the restricted area when barges and pleasure craft attempt to pass through at the same time as the dredge was in operation. The present series of spoil deposits between river mile 16.5 and river mile 17.5 would probably increase in width and length, become interconnected, and reduce some circulation of water in the vicinity of Hudson. Secondary movements as a result of wind or water erosion could also cause additional damage to the unique bottom fauna within this area. Projected average annual costs would be approximately $15,000.

b. Selective placement - Four sites could be selected under the selective placement alternative and would require little or no increase in plant capability. An additional 75 acres could be added to the already existing 50 acres of open sand areas resulting from dredged material placement. Site selection could take into account already existing land areas such as the two protruding land masses near Hudson, Wisconsin, river mile 16.7 and river mile 17.4.

It could be expected that the spoil sites near Hudson would be stabilized with vegetation to prevent erosion. They would also be intensively used for recreational purposes, which might necessitate construction of sanitary facilities or other recreation-related facilities such as restaurants or boat launching ramps. The area of the Kinnickinnic River delta, river mile 6.0, could also receive high use by recreational users. In addition, the high intensity use may require development of recreational facilities. Average annual costs for recreational development and increased plant capability could exceed $100,000.

c. Remote disposal - The remote disposal alternative would require an additional 75 acres for dredged spoil placement. Two major sites were selected due to their proximity to current dredge cut areas and the relative absence of equally good sites. Expanded plant capability could be required for placement of dredge materials at river mile 17.5 and would require approximately 8,000 feet of floating pipe.

The principal type of habitat loss would occur alongside the main channel areas. No particularly sensitive areas would be expected to be affected. Establishment of vegetation for wildlife habitat and stabilization of dredged materials could account for a gain of possibly 70 acres of woodland brush and shrubs and grassland. The remaining 50 acres of open sand areas could be developed for potential recreational use. Access to the main areas of spoil deposition could be by recreational craft and from nearby highways. It might be expected that the scenic value of the river coupled with relatively high quality water could make the area especially attractive to tourists from local

urban areas such as Hastings and further removed cities such as Minneapolis-St. Paul. The average annual cost for implementing this alternative in the St. Croix River could exceed $100,000.

d. Central disposal - It was determined that no suitable, single area large enough to contain the 50 acres necessary for future dredge spoil can be located along the St. Croix River and that the plant capability increase required to move all of the dredged material to one spot in the St. Croix pool would be sufficient to carry it to a more suitable site in pool 3. The material could best be rehandled in its movement to pool 3 rather than provide one long pipeline. Average annual costs could be approximately $655,000.

e. Removal from floodplain - Two 10-acre sites could be selected for placement of dredged material removed from the floodplain. The sites could be located on either side of the river and could be expected to receive an average annual amount of 20,000 cubic yards. Both sides should be easily accessible by barge facilities or railroad equipment for loading and transport to a different area. Subsequent utilization of the material would then depend upon transportation distances and the intent of its use. Habitat loss would occur within the category of main channel border.

6.297 A site located at river mile 5 may prove to be feasible for moving the materials to Stillwater, Hastings, or to the general area of Minneapolis-St. Paul. A site located near Hudson, Wisconsin, river mile 17.6, could prove to be less desirable in that the scenic attractions along the shore may be affected. In addition, annual deposition and near-continuous removal could disturb the bottom organisms significantly. Average annual costs could exceed $190,000.

POOL 3

6.298 Pool 3 possesses certain characteristics that merit special consideration when selecting alternative measures that might best be applicable. Important considerations include its proximity to Hastings and Minneapolis-St. Paul, the relatively high recreational use, and the valuable mixed resources of floodplain forest and aquatic habitat types.

6.299 Alternative measures - The most pertinent alternative measures considered for pool 3 include the following:

a. Revegetation - Contained within the boundaries of its floodplain, pool 3 has a considerable amount of terrestrial habitat types, principally floodplain forest. A program of vegetation establishment on spoil sites should probably take into account the relative amounts of habitat types and therefore some consideration should be given to increasing relatively scarce types, especially if they are considered more productive in terms of wildlife. For example, in the lower one-half of

the pool, a greater proportion of aquatic types exist compared to the upper one-half of the pool. The creation of dense grassland types may aid in creating waterfowl nesting sites. Wildlife enhancement might also occur if revegetated areas increase habitat diversity or if planting particular species produces high quality or specific types of fruit. There appears to be a definite need for stabilization of spoil sites in or near the main channel. This could also apply to future sites selected away from the channel. Stabilization could assist in preventing dredged material from washing back into the channel or from encroaching into backwater lakes and sloughs or backwater openings.

b. Selective placement - Selective placement could alleviate some of the undesirable conditions now appearing along the channel borders. Considerable portions on either side of the channel are continually being deposited upon and some of the main channel islands are approaching the point of being totally covered. The plan could utilize floodplain forest lands somewhat removed from the main channel and at the same time provide possibilities for recreational utilization or development. Adequate revegetation measures could provide additional and possibly more productive wildlife habitat. During times of extreme flooding, the vegetated areas which are more elevated than the periodically flooded forested areas might serve as wildlife sanctuaries for terrestrial mammals and birds. Lower lying areas might then be repopulated at a faster than normal rate.

c. Removal from floodplain - Stockpiling areas could be located at four sites scattered along the length of the pool. The sites could be near to the main channel and also provide access by rail or highway. The stockpile areas would probably have to be located on the Wisconsin shoreline because the main channel throughout most of this pool runs parallel to and very near its shore. Extensive areas of land, marsh, or water separate the navigation channel from the Minnesota shoreline.

d. Dredge openings into backwaters - Pool 3 contains two large bodies of water, North Lake and Sturgeon Lake, that, as a result of improperly placed dredged material or unforeseen secondary movements due to erosion, could have their source of freshwater reduced or eliminated. Maintenance of circulation as a result of dredging the openings could be an important technique in assuring both continued boating access from the main channel and adequate circulation of water to alleviate effects of increased rates of eutrophication and subsequent decreases in quality.

The openings at the lower end of the lake which permit water to escape and enter back into the river system are as important as those areas permitting fresh water to enter. The 2 miles between river mile 797 and river mile 799 are a critical area for water to leave Sturgeon Lake. No dredging has taken place in that area, but there is a possibility that naturally deposited materials could accumulate and effectively impound the lake. If blockage occurred, then remedial measures to open the area might be considered.

e. Expanded dredge plant capability - Plant capability would have to be increased for nearly all of the alternative plans. The largest plant capability increase would be realized for the central disposal plan. At least 6 miles of floating pipe would be required to reach all dredged areas of the pool. An expansion of dredge plant capability up to 6 miles of floating pipe would require a number of booster pumps. In addition, navigation hazards would undoubtedly increase due to the amount of exposed floating pipe and tending barges scattered over 6 miles of heavily used river channel.

f. Revise locking priorities - Pool 3 was estimated in 1963 to have received 200,000 recreationally oriented visitation days, the third highest rate in the District for that year. Lock No. 3 has demonstrated a substantial increase in lockages since 1960 while lock No. 2 has demonstrated a more moderate increase. Many larger yachts are docked on Conley Lake and apparently move southward toward Lake Pepin and the lower pools. With the substantial amount of pleasure craft making use of the pool, alterations of locking priorities may be desirable or necessary at lock No. 3. Lockages might be performed more often, specifically for pleasure craft which are more numerous than commercial craft, especially during peak demand periods during the day, on weekends, and holidays.

g. Commercial use of dredged material - Dredged material could be used for a variety of purposes, including fill material, sanding streets, or as aggregate for construction materials. The important consideration, other than demand, would be increasing costs with increased haul distance. Urban centers such as Hastings or Red Wing are potential markets due to their proximity to pool 3. A sufficient demand might exist in the Minneapolis-St. Paul area to make it economically feasible to transport the material there.

h. Recreational beaches - As recreational usage of pool 3 is relatively high, it could be reasonable to assume that beach areas would be intensively used for picnicking or camping. It should be added, however, that recreational use or demand might be less than expected since the pool is located within the "Recovery Zone" of that portion of the river which receives and attempts to assimilate or degrade the assorted types of effluents discharged into the river from Minneapolis-St. Paul. Existing beaches could be enhanced or "freshened" by the addition of new dredged materials. New beaches could be created in areas where demand might be expected to be high and beach areas limited in terms of desirability, access, or quantity. It is also possible that some areas of Sturgeon Lake could receive some dredged material for beach development if it could be demonstrated that demand is high.

i. Wildlife habitat - Revegetation of existing and/or new spoil deposits could provide additional areas of wildlife habitat. Vegetation types designated for particular sites could fit into a management plan

to encourage population increases of scarce or especially desirable species. For example, spoil materials placed in the vicinity of North Lake and Sturgeon Lake could be revegetated with dense perennial grasses which could provide excellent waterfowl nesting habitat for ground nesting species. Vegetative establishment along floodplain forest types might take into account the desirability of habitat diversity. For example, high quality brush types might be planted to provide browse for deer.

6.300 Alternative plans - Particular alternative plans appear to have more merit than others when considering overall impact and/or costs. The major effects and impacts of implementing the alternative plans described for pool 3 are presented in Exhibit 200. The location of the selected future dredge spoil sites are presented in Exhibit 214. A theoretical plan-by-plan description is presented as follows:

a. Status quo - The alternative plan of status quo would add 240 acres of open sand areas to the already existing 125 acres in pool 3. No increase in plant capability would be required. Decreases in aquatic and terrestrial habitat could occur if the plan was implemented. An estimated 155 acres of floodplain forest would be affected to some degree and a loss of 55 acres of channel borders and 15 acres of backwater sloughs could occur.

Portions of the navigation channel might eventually take on the appearance of sand banks on both sides and paralleling the main channel. These areas could include that portion of the river between river mile 803.0 to river mile 799.0. Accumulated spoil deposits in conjunction with only a small degree of secondary movements due to erosion could probably endanger important backwater openings. At river mile 803.4, Jackson Run permits the entrance of fresh water and probably provides access into North Lake. Miley Run and Hardy Run could also be affected by secondary spoil movements. Sturgeon Lake receives fresh water from backwater openings located at river mile 800.9 and river mile 799.8. Projected average annual costs could exceed $35,000.

b. Selective placement - Selective placement of dredged materials could add 190 acres of new open sand areas to the already existing 125 acres. Six sites could be selected for this alternative. The majority of the locations could be located on the Minnesota side of the channel due to the abundance of floodplain forest. They could be evenly spaced along the length of the pool. The sites could range in size from 25 to 40 acres. Selective placement could result in a loss of 45 acres of channel border areas and 85 acres of floodplain forest types. Under a plan of equal allocation of habitat types (grassland, trees, and shrubs), a gain of 80 acres of grassland could be realized. A net gain of 50 acres of open sand areas could be utilized as recreational areas. Plant capability would have to be increased to approximately 6,000 feet of floating pipe and 500 feet of shorepipe. The average annual cost would be about $280,000.

In conjunction with the high recreational use, a recreational acreage allotment plan could designate that three separate sites totaling 95 acres be developed with sanitary or other types of facilities. An additional 80 acres of scattered, open beaches could remain as they are and would accommodate the recreational overflow from the more intensively developed sites. The one site located at river mile 811.5 at the head of Prescott Island could prove to be a valuable recreation site. This location provides a view of the confluence of the St. Croix and the Mississippi Rivers and the possibility of a nature trail on unspoiled sections of the island. A loss of 45 acres of backwater slough could occur as a result of initial deposition or secondary movements. The dredge spoil site located at river mile 802.7 could also conceivably affect some sections of North Lake if inadequately stabilized.

c. Remote disposal - The remote disposal alternative could add an additional 165 acres of new spoil material to pool 3 with a range in size from 35 to 75 acres for the three possible sites. The three sites could be most suitably located on the Minnesota side of the channel. An increase of 12,000 feet of floating pipe and 2,000 feet of shorepipe would be required to place the material on the sites. The average annual cost would be about $390,000.

Habitat loss could occur to a limited extent among aquatic habitat types, including 15 acres of backwater sloughs. Considering that adequate revegetation measures would minimize the overall terrestrial habitat loss, the only net loss would occur in areas remaining unvegetated because of recreational designation. Any one of the three sites could be designated as a developed recreational site with development limited to sanitary facilities. Under most conditions, none of the spoil sites could be considered as threatening backwater openings or other aquatic habitat types.

d. Central disposal - The central disposal site could consist of a 120-acre area and be located near the navigation channel at river mile 805.0. The dredged spoil from the St. Croix pool could also be placed in this location. The additional 50 acres required to accommodate the dredged spoil from the St. Croix River would require a total of 170 acres to be selected for future dredge spoil disposal. Including the existing spoil sites, a total of 295 acres within pool 3 could consist of open sand areas as a result of dredged material placement with this alternative. Principal habitat loss could occur among the floodplain forest types and could amount to approximately 85 acres. An increased plant capability would be required to implement this particular plan and consist of six miles of floating pipe and approximately 2,000 feet of shorepipe.

The spoil site would be rather large and could offer an extremely large recreation area. An estimated 105 acres could be developed for intense recreational utilization and the remainder divided into woodland brush and shrubs as well as grassland. The average annual cost for this alternative could exceed $470,000.

e. Remove from floodplain - Four sites could be selected for stockpiling materials along and near the navigation channel of pool 3. The areas designated for spoil placement would total 30 acres with most of the loss of natural habitat occurring along the borders of the main channel. Railroad and barge access is excellent at all of these locations.

The site located near river mile 810.4 could prove to be the most feasible for the upper part of pool 3. The stockpiling site is located on the Wisconsin side of the channel, although more potential markets probably exist on the Minnesota side. None of the possible sites for stockpiling appear to be a threat to any particularly sensitive areas or habitat types. The average annual cost would be almost $500,000.

POOL 4

6.301 The most notable feature of pool 4 is Lake Pepin, which has been formed by the delta of the Chippewa River. It is centrally located within the pool and probably exceeds any other single portion of the river in terms of recreational potential. Lake Pepin also serves a valuable biological function by acting as a settling basin for fine sediments on its upper end and as a cleaning system for effluents from large urban areas to the north. A number of river lakes, ponds, and sloughs also exist at both ends of the pool. The amount of material dredged from pool 4 annually is substantial and exceeds that of any other pool in the St. Paul District. The Chippewa River contributes the majority of this sediment.

6.302 Alternative measures - Considerations of various alternative measures for handling dredged materials are considered in the following sections.

a. Sediment deposition control structures - It is theoretically possible that sediment deposition control devices might reduce the amount of material transported into pool 4 by the Chippewa River. Control structures could take various forms. One treatment already attempted was the excavation of bottom materials along the Chippewa River upstream but near the confluence of the Chippewa River and the Mississippi River main channel. New materials traveling down the river would theoretically first settle into the excavated area. As it turned out, the "hole" filled up within a year and had no apparent impact on the amount of materials entering the navigation channel.

A sediment barrier could be constructed in the form of an underwater dam which could theoretically intercept heavier bedload materials and at the same time permit navigation access and passage of water during non-flood periods. The underwater dam could be constructed of concrete, riprap, or other materials considered most desirable. Once material had been "entrapped" it would have to be periodically removed, otherwise bedload materials would increase behind the barrier and possibly circumvent

its original purpose. Other methods of reducing sediment movements into the Mississippi River and specifics of construction are presented in the alternative measure section.

b. Selective placement - This particular type of placement appears most practical in terms of limiting the increase in plant capability and selectively choosing sites on the basis of being less environmentally sensitive than present disposal sites. Adequate revegetation techniques could assist in stabilizing the dredged piles and possibly prevent secondary movements and subsequent backwater channel and slough filling as well as reduce the amount that could reenter the navigation channel. Selective placement of materials could also aid in moving the dredged materials further away from the channel.

c. Size of dredge cut - Three areas along the Mississippi River below the Chippewa River confluence are dredged on an almost annual basis. The areas are near river miles 763, 759, and 758. These locations require dredging almost annually regardless of the amount of material removed. Therefore, a shallower dredge cut might reduce the amount of material removed not only for one particular year but perhaps also over a period of years. However, such reductions in the dredge cuts may make it necessary to return later in the season to redredge the same area in order to maintain navigation.

d. Dredging openings into backwaters - A few openings above and below Lake Pepin may be susceptible to filling due to secondary movements of dredged material and naturally occurring sediment deposition. Specific areas appear to be located at river mile 790 at the entrance to Lower Lake (Dead Slough) and in the vicinity of Indian Slough at river mile 759.5 leading into Big Lake. Specifics concerning dredge size, cost, and minimum depth and width requirements are contained in the preceding general discussion of alternative measures.

e. Expanding dredge capability - Except for the alternative plan of status quo, all plans of dredged material placement would require varying degrees of plant capability increases. The necessity of transporting the material further distances from the dredge cut could be required in situations where adverse impacts could definitely be alleviated. Selective placement appears to be practical in this particular pool and plant capability would have to be increased by a moderate amount. Increases of plant capability would most likely take the form of increased lengths of floating or shore discharge pipe with booster pumps at required intervals. Specifics concerning estimates of plant capability increase and associated costs are presented in the preceding alternative measures section devoted to expansion of dredge capability.

f. Recreation beaches - The recreational demand of the pool areas above and below Lake Pepin is probably less than the demand in the lake itself. However, pleasure craft traveling into the pool from above

or below the confining locks might make considerable use of such areas. Therefore, dredged material could be used to create or freshen existing beach areas. Large spoil deposits might also be developed to provide sanitation facilities, fresh water, or other conveniences not presently found on undeveloped beaches. Particular areas of heavy use might develop immediately above or below Lake Pepin and possibly in the Wabasha area.

g. Wildlife habitat - The amount of open sand areas attributable to past and future dredged spoil placement is considerable and probably exceeds all requirements for recreational use. Therefore, a substantial proportion of the spoil areas should be reclaimed for wildlife production. Encouragement of wildlife production is dependent upon adequate revegetation of the spoil areas. Adequate revegetation methods could give prime consideration to specific species which could supply nesting habitat, food production, and escape cover. An area which maintains an adequate vegetative cover would also assist in stabilizing the materials.

Revegetation of spoil areas into grassland might provide a means of diversifying the habitat, increasing "edge" effect and meeting specific needs of highly desirable species. For example, waterfowl nesting might increase in terms of numbers or nesting success. Spoil deposits at or near backwater sloughs or lakes offer more potential brood habitat within pool 4 could be located at river miles 790 and 758 where brood habitat possibilities exist in Mud Lake and Big Lake.

6.303 Alternative plans - General impacts and types of habitat losses are presented in Exhibit 201. The selected locations for spoil disposal for the alternative plans is given in Exhibit 215. A review of the alternative plans is presented in the following paragraphs.

a. Status quo - Status quo would add an additional 485 acres of new spoil to the already existing 555 acres in pool 4. The contribution of new materials to already existing areas would probably give the appearance of alternating segments of sand deposits parallel to, on both sides of, and near the navigation channel. Obvious areas which could appear this way include stretches of the river at river miles 794, 793, 790, 759, 758, and 756. Particularly sensitive areas of backwater channel openings and backwater sloughs could continue to be threatened due to unconfined, unstabilized spoil deposits. Greatest losses of aquatic habitat types, as much as 175 acres, could occur in channel borders and backwater sloughs. An increase in open sand areas could occur. Plant capability would have to be increased, especially in the Crat's Island area, where within the next 5 to 10 years additional plant will be required. Average annual costs could exceed $97,000.

b. Selective placement - An increase of 445 acres of open sand areas could be expected under this alternative plan. Spoil areas could be confined to about ten sites, six below and four above Lake Pepin. An increase in plant capability of approximately 6,000 feet of floating pipe and 1,000

feet of shorepipe would be required. The largest individual site could be located immediately below the confluence of the Chippewa and Mississippi Rivers on the existing delta. A recreational site of 40 acres could be developed on this site with the remaining old and new acreage revegetated to benefit wildlife. Habitat loss could occur principally among aquatic types, channel borders, and backwater sloughs. Open sand areas could be reduced by a possible 205 acres if adequate revegetation measures were implemented. No backwater channels or openings would be threatened. The average annual cost for implementing this alternative plan would be approximately $703,000.

c. Remote disposal - Six sites could be designated for the plan, ranging in size from an estimated 20 to 140 acres, three below and three above Lake Pepin. An additional 380 acres would have to be designated for receiving future spoil materials. Plant capability would have to be increased to 11,000 feet of floating pipe and 6,000 feet of shorepipe to reach all of the designated areas. Aquatic habitat loss could occur principally among channel borders and backwater sloughs. A possible loss of 175 acres could occur. Adequate revegetation measures applied to existing or future sites could account for a net loss of 260 acres of open sand areas. Remaining open sand areas could be designated for recreational development (130 acres) or remain untouched (160 acres) to provide for recreational overflow. The larger of the areas, if adequately revegetated, could provide a substantial amount of mixed or monotypic habitat which could conceivably support viable populations of wildlife species not presently found within the floodplain forest. Average annual costs for implementing the remote disposal alternative plan in pool 4 could exceed $800,000.

d. Central disposal - This plan could involve the selection of two sites, one above and one below Lake Pepin. The acreage required for deposition could total 340 acres. Plant capability would have to be increased to approximately 5 miles of floating pipe and 2 miles of shorepipe to implement this plan. The floodplain forest would lose approximately 300 acres. However, an adequate program of revegetation could eventually reduce this loss to about 80 acres and result in a gain of grassland types at the expense of open sand acreage. The average annual cost for implementing revegetation measures and purchasing additional dredging equipment could exceed $1,690,000.

e. Remove from floodplain - The plan could involve the selection of five sites for stockpiling materials prior to transporting the materials out of the floodplain. All sites could be accessible by railroad and in some cases also by barge equipment. Plant capability would have to be increased to at least 3 miles of floating pipe and 1/2 mile of shorepipe to move the majority of dredged materials to the stockpile areas. Potential markets and related practicability of the plan are probably limited to Red Wing in the upper section and Wabasha in the lower area of the pool. A potential demand for beach development or enhancement could exist along the shore of Lake Pepin and spoil could be transported to the required site by barge or railroad equipment. Average annual costs for implementing this alternative plan could exceed $1,713,000.

6.304 Pool 5 offers a great deal of recreational potential in terms of fishing, hunting, and related camping activities. Weaver Bottoms is well known as a waterfowl sanctuary and hunting area. The remainder of the pool contains a complex of islands, bays, sloughs, and river lakes. As notable as pool 5 is for its assets, it is also known for its problem areas. Within a 6-mile stretch of the navigation channel, dredging is required annually and considerable amounts of dredged material is accumulating parallel to and on both sides of the channel. The flow into the Weaver Bottoms area has been altered significantly since the 9-foot channel project created the large open water area. In part, this alteration of flow is due to the placement of dredge spoil along the lower part of Weaver Bottoms from river mile 743 to river mile 747.

6.305 <u>Alternative measures</u> - Alternative measures which appear most likely to be applicable in pool 5 are presented in the following sections:

a. Revegetation - Spoil deposits which are prone to possible erosion or located such that waterfowl brood habitat is available a short distance away could be revegetated. It is probable that islands with a dense cover of grass would benefit ground nesting waterfowl. Relative stability could also be achieved due to the dense nature of grass root systems and protecting cover of residual vegetation.

b. Selective placement - Approximately nine locations could be designated for deposition of future spoil materials. A moderate increase in plant capability would be required. Selective placement has two distinct advantages. It would alleviate some of the existing pressure on existing spoil sites and confine more of the material in one particular place. The lesser number of sites could possibly be more easily revegetated and/or confined. More flexibility is present in this measure compared to present disposal techniques. For example, it could be possible to extend one or more barriers into Weaver Bottoms to reduce the effects of wave action on aquatic vegetation. Other than the possible loss of backwater habitat due to the construction of these barriers, no extensive areas of backwater habitat or backwater openings would appear to be affected by this alternative measure.

c. Size of dredge cut - Most dredge cuts in pool 5 have to be annually dredged, particularly between river mile 747 and river mile 743. It is conceivable that the depth of the dredge cut and, subsequently, the annual amount of material deposited on nearby land areas could be reduced. The disadvantage of this measure might be that the cut would unexpectedly fill during the navigation season. It would then impede or halt barge traffic and the dredge would have to be recalled to the area to remove the material.

d. Dredge openings - The backwater openings at the north end of Weaver Bottoms and along its eastern edge are at the present time filling, thus reducing the flow of water and recreational access to the area. Other critical areas include the Pomme De Terre (Belvidere) Slough which includes Roebuck's Run and Sand Run.

Circulation through the Weaver Bottoms area has been altered by deposition of dredged materials. The islands existing on the west side of the channel between river miles 745.5 and 743 were created by dredged material deposits. The large quantities of water which had previously circulated throughout the southern end have now been limited to relatively minor flows through narrow openings which are becoming increasingly narrow.

e. Increase in dredge capability - With the exception of the status quo alternative, dredge capability would have to be increased to fulfill the requirements of all alternate plans of spoil placement. Increases would be greatest for central disposal and the least for selective placement. The increase in plant capability would most likely involve an increase in the length of discharge pipe with booster pumps spaced at required intervals to maintain certain levels of efficiency. Among those portions of the channel in which most dredging occurs, it could be expected that navigation hazards could result if the length of discharge pipe became unwieldy or had to cross the center of the navigation channel. Considerable time would be lost if the pipe had to be broken repeatedly to permit commercial and recreational craft to pass.

f. Change water levels - Increasing or decreasing water levels at particular times of the year might be beneficial. For example, large areas of the Weaver Bottoms section might be made shallower or deeper at a particular time to encourage the growth and expansion of submergent or emergent aquatic vegetation vital to continued waterfowl use. Contingent upon attempting to reduce the size of the dredge cut, water levels might be increased in an emergency situation until the dredge could return to preclude the stoppage of barge traffic due to an unexpected filling of the cut. Increases in water levels would cause some flooding of private land and a decrease in discharge rate at lock and dam No. 5. Decreases in water levels might also cause problems in terms of navigation. Moderate increases or decreases could be accomplished with little or no modification of locks and dams No. 4 and 5.

It is recognized that problems would arise with both water level increases and decreases. It would be expected that any proposed plan would take into account all negative and positive aspects and also be well-coordinated with other responsible agencies. It could reasonably be predicted that overall quality of wildlife habitat could be increased without any detrimental effects to navigational interests.

g. Recreation beaches - Dredged spoil could be used to freshen older beaches or create new ones in areas where the quality or quantity is lacking and where demand could be expected to be high. Beach areas in the vicinity of Weaver Bottoms could be used for camping and especially for observing the diversity and quantity of waterfowl. Other areas could be used for the normal variety of recreational activities. Buffalo, Wisconsin, is the only town of appreciable size in pool 5 and overall recreational demand from residents could be expected to be moderate. Greater demand would probably come from boaters passing into or through the pool from other areas.

h. Wildlife habitat - Adequately revegetated spoil areas would support more wildlife than if the area was left in its "sand pile" condition. Additional benefits to wildlife might be realized if plant species especially valuable as food and nesting or escape cover were selected for revegetation attempts. Areas bordering Weaver Bottoms might provide excellent nesting sites for ground nesting waterfowl such as mallards and teal. Therefore, the establishment of a dense grass covering on islands could be of a considerable benefit to the overall nesting potential.

It appears as if a secondary benefit to wildlife could result if "barrier reefs" were extended out from the sides of the navigation channel bordering Weaver Bottoms. In this situation effects of wave action could be moderated to encourage aquatic vegetative growth. The barrier itself could be vegetated section by section as it extends out further in increments equalling annual dredging amounts.

6.306 Alternative plans - Alternative plans for pool 5 are variable in terms of required plant capability increase and the amount of required acreage for receiving spoil materials. General impacts of alternatives and location of selected dredge spoil disposal sites are presented in Exhibits 202 and 216, respectively. A discussion of each alternative plan is presented in the following sections.

a. Status quo - Status quo would add an additional 350 acres of new spoil deposits to the already existing 305 acres. Placement techniques would not be altered substantially and no increase in plant capability would be required. Principal types of habitat loss could occur among both aquatic and terrestrial types. An estimated loss of 25 acres of open lake types, 25 acres of channel border, and 110 acres of backwater sloughs could occur. Approximately 190 acres of floodplain forest types could also be lost. The potential threat to blocking backwater openings would remain and most likely increase. The section of river located between river mile 747 and river mile 743 would probably resemble a "channel" after a relatively short period of time. Average annual costs could be approximately $56,000.

b. Selective placement - This alternative plan would require eight or nine sites spaced somewhat evenly along the navigation channel. An

additional 270 acres would be required, a maximum amount being deposited at one site of 40 acres. Noticeable habitat loss could occur among open lakes (40 acres), backwater sloughs (115 acres), and open sand areas (135 acres). An increase in plant capability of approximately 10,000 feet of floating pipe and 500 feet of shorepipe would be required.

None of the selected sites appeared to threaten backwater channel openings or in other ways inhibit backwater circulation. It was estimated that some of the areas could provide excellent sites for recreational development in terms of camping areas and related facilities. If spoil piles were adequately vegetated, a substantial acreage of both old and new habitat could support various kinds of wildlife. In addition, a protective vegetative cover could substantially reduce secondary movements of spoil materials by water or wind erosion. The average annual costs for revegetation, recreational development, and increased plant capability could be approximately $374,000.

c. Remote disposal - Two sites were designated to receive spoil materials in pool 5 for this particular alternative plan. One site of especially large size could be selected in the northwest section of Weaver Bottoms. This area could be accessible by watercraft and automobile and could be intensely developed for recreational use. The principal type of habitat loss could occur among the backwater sloughs of Weaver Bottoms. Plant capability would have to be increased to approximately 17,000 feet of floating pipe and 1,000 feet of shorepipe to transport dredged materials the required distances. Average annual costs for implementation of this alternative plan could exceed $638,000.

d. Central disposal - The single location for this alternative could be located in the northwest section of Weaver Bottoms. The site could occupy approximately 180 acres and major habitat losses would take place in backwater sloughs. The required plant capability increase would be on the order of 5 1/2 miles of floating pipe and possibly 1,000 feet of shorepipe. The area could be accessible by both water and road and could be intensively developed into a high density recreational area. No openings into backwater sloughs and lakes would appear to be threatened by this alternative plan. Total costs on an annual basis for implementing this alternative plan in pool 5 could exceed $715,000.

e. Removal from floodplain - Two sites could be selected and designated as stockpiling areas for this alternative plan and yet remain relatively close to the main areas of dredging. Both sites are potentially accessible by water, railroad, or highway. However, the site located at Indian Point near river mile 748 would require additional dredging of shallow area to permit barge accessibility. A plant capability increase of approximately 15,000 feet of floating pipe would be required to reach all of the major dredge cuts. Transportation costs of removing the materials from the stockpile area to a

demand point might be excessively high for pool 5 as no large sized urban areas exist within its immediate vicinity. The average annual costs for increased plant capability, recreational development, and maintenance and for various revegetation programs could exceed $854,000.

POOL 5A

6.307 Alternative measures - Pool 5A has characteristics for which specific alternative measures could have merit. These particular measures include the following:

a. Revegetation - It could be considered that adequate revegetation of spoil areas not designated for recreational use could assist in stabilizing the material, reclaim areas for wildlife use, and enhance the natural aspects of the area. No particularly sensitive areas appear threatened by secondary movements of spoil as a result of improper placement and/or erosion. A degree of stabilization due to effects of vegetation may prevent some materials from returning to the channel.

The attractiveness of the area in general is dependent on the "naturalness" of the landscape. Bare spoil sites are reminders of human activity and their revegetation would probably enhance the area.

b. Selective placement - Six sites could be selected for the alternative plan of selective placement. The sites could be located on either side of the navigation channel within one-half of a mile from the centerline of the channel. These sites would require an increase in plant capability. It could not be demonstrated that any of the potential sites would pose a problem to backwater channel openings and all of the sites could be within easy access to the main routes of recreational water craft.

c. Remote disposal - Two sites could be selected for remote disposal. One potential 80-acre site 1.5 miles southwest of river mile 735 would require a considerable increase in dredge plant capability. The other site could be located near the main channel at river mile 731.5, which offers excellent possibilities for recreational access by road. Neither of the sites appeared to threaten backwater sloughs or openings.

d. Removal from floodplain - Four potential sites could be designated for this particular measure. However, site selection could be complicated by the fact that none of the sites are easily accessible to either barges or railroads. It was considered that railroad pickup and handling would probably be more practical than barges. The areas could be approximately 15 acres in size, with one located on each side of the navigation channel.

e. Size of dredge cut - One area within pool 5A appears to lend itself to a reduction in size of dredge cut and a subsequent reduction in the annual amount of material removed. The particular area lies between river miles 734 and 735 and yields an average of about 50,000 cubic yards annually. Dredging appears to be required almost annually regardless of runoff conditions or the quantity of material removed the preceding year. Therefore, a possibility exists that the annual removal might be reduced and at the same time not adversely affect commercial navigation. However, this measure may present additional hazards. An example would be the problem of having to return later in the season for emergency dredging.

f. Expansion of dredge capability - Increased length of pipe and booster pumps would be required for reaching sites which could be designated for all of the placement alternatives. Site selection criteria could be modified by using this alternative measure. An excessive accumulation of sand along the shoreline areas paralleling river miles 733.5, 735.0, and 729.0-732.5 could be prevented if dredged materials could be placed on a minimum of sites or away from the main channel.

g. Revise locking priorities - Recreational demand and lock utilization appear high for this particular pool. Lock 5 has not increased its pleasure craft lockages over the last 12 years, but lockages through lock 5A have nearly doubled (from 2,800 to 5,300) over the same time period. High utilization of the pool is probably based on the large number of islands contained within the pool, the access it provides to pool 5 and Lake Pepin and the presence of Merrick State Park which attracts many Winona residents. Pleasure craft lockages could be altered to satisfy high demand during particular periods of the year, week, or day. For example, on holidays or weekends, lockages could be conducted every hour on the hour for pleasure craft alone.

h. Commercial commodity - Dredged material could be used for fill materials, sanding of streets, or for recreational purposes. However, a severe restriction might exist in regard to hauling distances as the pool is relatively distant from large commercial or urban areas. The exception to this would be the close proximity of Winona, Minnesota, where interest in using the material for fill purposes has recently been expressed.

i. Recreation beaches - Dredged materials could be used to replenish existing beach areas which for one reason or another have lost a degree of desirability. Reasons for this loss could be attributable to natural plant succession, erosion, or intensive recreation use and accumulation of litter. New beaches could also be

created in areas lacking suitable numbers or in areas which receive greater than normal use. Creation of more off-channel sites might be considered desirable if more seclusion enhances its recreation potential. In all instances, careful consideration should be given to possibilities of serious erosion or inaccessibility. Five public access sites apparently exist in a well-distributed pattern. Future consideration might be given to development of beaches at these sites to promote a wider spectrum of recreational uses, other than boat launching and parking.

j. Wildlife habitat - Due to the amount of existing habitat already available in pool 5A, the reclamation of spoil areas into productive wildlife areas would probably not be significant. The amount of wildlife habitat reclamation would be even less if recreation demands claimed a large portion of new spoil areas. However, significant changes in the quality of wildlife habitat might be apparent if the problem was examined in terms of creating nontypical sites. Smaller islands along heavily dredged areas could be planted with grass species to encourage waterfowl nesting. Larger islands might benefit from an increased habitat diversity. For example, a site located in an extensive area of floodplain forest could be planted in grassland or brushland types.

The Polander Lake Wildlife Sanctuary appears to be losing its value to waterfowl. Circulation through Pap Slough appears to be very important and serious consideration should be given to avoiding future spoil deposition in the area. Similar consideration should be given to the area along river mile 730 and river mile 731 to avoid circulation loss at the outlet of Polander Lake.

6.308 <u>Alternative plans</u> - The alternative plans evaluated in pool 5A are discussed in the following paragraphs. The impacts and effects of implementing these plans are tabulated in Exhibit 203. The locations and acreages of future dredge spoil sites are listed in Exhibit 217.

a. Status quo - Continuation of present dredging techniques and the selection of the nearest deposition site could result in approximately 175 acres, in addition to the present 140 acres, being utilized for dredge spoil. Limited expansion of plant capability would be required. Adverse affects could probably increase in the areas between river miles 733.5 and 735.0 and river miles 730.0 and 732.5 where past spoil deposits appear to be parallel and on both sides of the navigation channel.

Habitat loss would occur in both aquatic and terrestrial types. Principal habitat losses would occur among channel borders and woodland brush and shrubs of the floodplain forest. Effects of water and wind erosion could probably cause secondary movements back into the channel area and some degree of adverse effects could be expected in backwater sloughs and openings. The estimated average annual costs would be approximately $33,000.

b. Selective placement - Site placement for this plan could involve a maximum of six sites ranging in size from 5 to 40 acres. The largest single unit could be a total of 40 acres on the west side of the navigation channel at river mile 734.5. The minimum size requirement to accommodate dredged material could be 5 acres located on the west side of river mile 738.

The total area within pool 5A which could be devoted to dredged material placement would be 140 acres of existing or older materials and 150 acres for new materials. A plan of allocation for recreational uses and forms of wildlife use could result in converting the spoil material acreage into 65 acres of beach areas, and result in approximately 80 acres of a grassland type.

Aquatic habitat could sustain a total loss of 50 acres with this plan. The majority of loss would occur within backwater sloughs. Terrestrial habitat could increase by 50 acres with the major increase being noted among grassland types if areas were revegetated, 50 percent devoted to grassland and 50 percent planted to woodland brush and shurbs.

Maximum plant capability for this plan could involve 6,200 feet of floating pipe and 600 feet of shorepipe. The most difficult site, in terms of placement of material could be at river mile 731.5 where the discharge pipe would have to be laid across water, land, and a railroad track. Passage past the track could be achieved by placing a fixed pipe beneath it. The average annual cost would be about $215,000.

c. Remote disposal - In addition to the existing 140 acres, the remote disposal alternative could require an additional 140 acres placed in two locations on either side of the navigation channel. Plant capability would have to be increased to approximately 6,000 feet of shorepipe and 8,000 feet of floating pipe. Habitat loss could occur primarily among river lakes and ponds. An increase of 75 acres of woodland brush and shrubs and 55 acres of grassland could be realized if adequate revegetation plans are implemented on both new and old spoil sites. Revegetation costs as well as additional equipment purchase could raise the average annual cost to approximately $315,000.

Two proposed sites could be partially revegetated to provide wildlife habitat and reduce the effects of water and wind erosion. The unvegetated area could provide open sand areas for

recreational use. The potential for intensive recreational use is possible in both areas as they are large enough to warrant development of sanitary facilities, nature trails, or boat launching sites. Both areas have excellent access from nearby highways from either Wisconsin or Minnesota.

d. Central disposal - The single site selected for central disposal could be located approximately 1.5 miles northeast of Minnesota City, Minnesota, or 2.3 miles southwest of river mile 732. The area could contain all of the dredged material from pool 5A for the next 50 years and would occupy an area of approximately 130 acres.

The principal loss of habitat could initially occur among the floodplain forest types. Little if any aquatic habitat types would be affected and no potential dangers can be foreseen as a result of secondary movements due to wind or water erosion. Grassland types could demonstrate the largest gain in acreage if revegetated areas were planted in grassland and woodland brush and shrubs on an equal acreage allotment. A portion of the disposal site facing the water area between Pickerel Run and Straight Slough could remain unvegetated and provide an area for recreational use.

An increase in dredge capability would be required to move the dredged material to the selected site. It was estimated that 12,000 feet of shorepipe and 8,000 feet of floating pipe would be required, with several land-water crossings being required for the shorepipe. The average annual cost for additional equipment purchase and revegetation of selected sites could exceed $525,000.

e. Removal from floodplain - Four sites of approximately 15 acres each could be designated as stockpile areas for either barge or railroad pickup. An expansion of plant capability would be necessary and could consist of 6,000 feet of shorepipe and 8,000 feet of floating pipe. However, location of a particular site was complicated by the fact that barge or railroad facilities could reasonably reach only one-half of the sites. Therefore, in the determination of the most reasonable method of handling the material once it was stockpiled, it was considered that railroad pickup might be most practicable. The location of the two areas posed no particular threat to unusually sensitive areas.

A possible stockpile area located 2 1/2 miles north of Minnesota City could probably serve some of the dredged material needs of nearby Winona, Minnesota. It is unknown at this time if it would be practical to transport the material northward over much greater distances to the larger-sized urban areas to the north. Average annual costs for increased plant capability and revegetation of selected sites could exceed $525,000 for implementing this alternative plan in pool 5A.

6.309 Pool 6 passes through the Winona area with most of the floodway narrowly confined between steep bluffs on the Minnesota side and a railroad levee on the Wisconsin side of the river. This floodway is further constricted by the Winona levee system. No large backwater lakes exist within the pool except for an "artificial" lake, the Delta Fish and Fur Farm, which is impounded by a railroad levee. Because of the floodway restrictions, any large midstream locations of dredged spoil would tend to affect flood stages. There appears to be a demand for dredged spoil materials in the Winona area, principally for land filling operations. The areas where fill is desired include a planned industrial park and facilities for grain storage.

6.310 Alternative measures - Alternative measures which appear to have specific merit for certain characteristics of pool 6 are presented in the following:

a. Selective placement - The selective placement measures takes into account the possible need for fill material, potential recreational use, and/or beach enhancement. The increased plant capability required for this measure would probably be less than other alternative plans except for the continuation of present practices.

b. Remote disposal - The remote disposal measure could involve the selection of a minimum of sites and yet remain consistent with locating a major landfill site in the vicinity of Winona. If the majority of the dredged material was used for fill, then fewer sites would be available for recreational development. The majority of sites would not be located near the main channel due to limited availability and the fact that large-sized disposal areas in this restricted floodplain could interfere with flood flows.

c. Expanded dredge capability - Expanded dredge plant capability would be required for most alternate plans of dredged material placement. The exception would be the status quo alternative. An increase in plant capability would probably require increased length of discharge pipe and the addition of booster pumps at required intervals to maintain an adequate flow of dredged materials.

In making site determinations, it is not a question of whether or not a desirable location could actually be reached. More important considerations include the cost of additional equipment, loss of time involved in tending the equipment, and the relative value of one site as opposed to another more removed.

d. Commercial commodity - Commercial utilization of dredged material could take the form of fill material, sand for streets in the winter, or use with an aggregate in construction materials. The greatest potential for use in pool 6 appears to be for fill material in the Winona area. A proposed site presently exists southeast of Winona. The area has been zoned and permission to fill in the area has been given by the various authorities. It has been estimated that the area could easily

accommodate 1.5 million cubic yards. Another potential fill area at Winona exists in the vicinity of Crooked Slough Harbor where an estimated 1 million cubic yards of fill could be required in the immediate future.

A fixed discharge pipe could be used to pass the material under a railroad track near the industrial area. Additional fixed shorepipe might also be installed to pass the material to the farthest reaches of the fill area. It is also possible that a monetary return might be realized from the sale of the dredged material.

6.311 Alternative plans - Individual or combinations of alternative plans along with various measures might best approach the problem of handling future spoil materials in pool 6. Certain aspects of each plan are considered in the following sections. The most serious consideration involved with the determination of feasibility would be the costs incurred with increased plant capability. Impacts and effects of dredged spoil materials as well as amounts and locations are presented in Exhibits 204 and 218.

a. Status quo - This alternative plan could add an additional 130 acres of bare sand areas to the already existing 265 acres in pool 6. Methods of deposition and site selection would be similar to present practices. Habitat changes could include a loss of 40 acres of aquatic types and a corresponding increase of 40 acres of terrestrial types. Principal types of habitat loss could include channel borders and floodplain forest types.

Between miles 720 and 724.5, the river could receive additional dredged material such that the aesthetic value of the area could decrease. The islands could also be totally buried to the extent that even minor traces of vegetation would disappear. However, this area is located near Winona and recreational demand for a great amount of bare sand areas for camping or picnicking probably exist. Average annual costs for this alternative plan are approximately $17,000.

b. Selective placement - Six sites could be designated for the reception of spoil materials under this particular alternative plan and could range in size from 5 to 80 acres. An additional 125 acres could be added to the already existing 135 acres of open sand areas. Approximately 8,000 feet of floating pipe could be required as well as approximately 1,000 feet of shorepipe. An estimated 115 acres of aquatic habitat could be lost, including channel border and backwater sloughs. The largest area of loss could occur in the marshland zoned for industrial development near Winona. Disposal areas could be revegetated to enhance wildlife production and to assist in stabilization.

Recreational use of new and old spoil areas would probably continue to be high. In this particular pool some consideration should be given to beach replenishment because the possible use of 80 acres for fill material might allow existing beaches to deteriorate. Older beaches could be spoiled upon in lesser amounts than in the past and the material

spread more evenly along the shore with mechanical equipment. No backwater sloughs would be threatened by this alternative. Average annual costs for implementation of this alternative plan could exceed $225,000.

c. Remote disposal - Three sites were selected within pool 6, ranging in size from 5 to 100 acres. The largest area was located at the proposed industrial development site. Approximately 12,000 feet of floating pipe could be required to transport dredged material to desirable sites.

Habitat loss could occur principally among backwater slough types. The most significant loss would involve 100 acres of marsh habitat in the industrial park area. Small gains in terrestrial habitat could be realized by revegetating older spoil areas to woodland brush and shrubs (10 acres) and grassland types (25 acres). Obviously, the greatest gain (85 acres) could be among open sand areas. Backwater openings or other relatively sensitive areas would not be affected. Average annual costs could exceed $200,000.

d. Central disposal - The site could be located at river mile 723 which is the site for the proposed industrial development area. The site is centrally located in the pool and would require an increased plant capability of approximately 4 to 5 miles of floating pipe. As stated for the previous alternative plans, the principal habitat loss could occur among marsh types due to the filling in of the industrial park area. Remaining areas of older dredged material could be revegetated for wildlife use or left as recreational beaches. A serious navigation safety hazard would result from the 4 to 5 miles of floating pipe. The physical problems associated with setting up and breaking down the dredge operation using this length of discharge pipe and associated booster pumps would require special handling. Average annual costs could be approximately $225,000.

e. Removal from floodplain - One site was chosen for stockpiling on the Minnesota side of the river at river mile 723. An increase in plant capability would be required of approximately 4 to 5 miles to reach all the dredge cuts in pool 6. The dredge cuts in the vicinity of river mile 723, however, account for the majority of dredged material in the pool and could reach the designated area with a plant capability increase of approximately 5,000 feet of floating pipe. Stockpiled materials could be transported away from the area by either barge or railroad facilities. The average annual cost for increasing plant capability, recreation development, and revegetation could exceed $300,000.

POOL 7

6.312 Investigation of alternatives in pool 7 considered several physical characteristics worthy of note and possibly of important value in making future plans. The large expanse of Lake Onalaska provides a very valuable aesthetic, recreation, and biological resource. Circulation channels and inlets into the lake are very critical to maintenance of its high value.

The nearby urban area of La Crosse, Wisconsin, provides a large source of recreation boaters for pool 7. Lock and dam No. 7 has had the greatest number of pleasure boats passing through the lock of all the locks in the St. Paul District. There is a large expanse of relatively remote floodplain forest near the center of the pool in the delta of the Black River which provides for much contrast in habitat types throughout the pool. The major dredging areas in the future are estimated to be located at about the following locations: river miles 704.8, 706.2, 708.5, and 711.7.

6.313 Alternative measures - Recognizing the above parameters, the alternative measures which appear to offer the most potential for reduction of adverse environmental impacts related to future operation and maintenance activities in pool 7 are: revegetation of disposal areas, selective placement, remote disposal, dredge openings into backwaters, expansion of dredge plant capability, change water levels in pool, revise locking priorities, development of recreation beaches, and development of wildlife habitat. The relative significance of each alternative measure for pool 7 is discussed in the following paragraphs.

a. Revegetation - The wildlife values of the backwater areas in pool 7 are relatively high. Replacement of these areas with a non-productive sand tends to degrade the value of the system to wildlife. Two open sand disposal areas are located directly upstream of channels into the backwater areas of Lake Onalaska, at river miles 708.6 and 706.5. Any indirect or secondary movement of sand from the disposal areas into these channels should be avoided. Revegetation of many of the disposal areas, especially large areas and those above the channels into Lake Onalaska backwaters would help to reduce any indirect spoil movements and would help to revitalize a valuable wildlife habitat. Revegetation of all areas would probably not be desirable as use of the sandy areas for recreation beaches is quite heavy. Revegetation of many of the spoil sites would improve the natural aesthetic value of the view along the river.

b. Selective placement - Dedication of about four areas in pool 7 to receive the future dredge spoil could be a desirable alternative. Several locations such as Dresbach Island, an island at Dakota, Minnesota, the west riverbank across from Winter's Landing, and Richmond Island, have all received dredged material and are located in areas which appear to have excellent potential for valuable recreational areas. Dredged spoil placed in these areas would have very little potential for causing any indirect adverse impacts. If any material would be lost due to secondary movement, it would probably go back into the navigation channel. These areas are located relatively close to the major dredging areas in the pool and the increase in dredge plant capability that would be required would not impose impossible restraints on the dredging activities.

c. Remote disposal - Although rather extensive requirements of dredge plant capability would be required, two areas in pool 7 have reasonably

good potential for consideration as future disposal areas. One is located in a floodplain forest area which is remote from both river and highway access and the other is located on Dresbach Island. Both sites would offer potential for development, one for recreation and the other for wildlife. The potential for adverse effects from secondary movements of dredge material from either site would not be of major significance.

d. Dredge openings into backwaters - There are several inlets to the backwater areas and into Lake Onalaska which appear to be filling with sediment. This filling if unchecked could cause adverse ecological and social impacts. The relationship of the operation and maintenance activities of the 9-foot channel project to the apparent closure of these inlets has not been clearly established. However, these channel inlets have a very important role in maintaining the environmental values of Lake Onalaska. Keeping these inlets open to allow a sufficient flow into Lake Onalaska would provide a continual supply of fresh oxygenated water into a lake with a high oxygen demand. These inlets might be dredged open to maintain this flow. The inlet at Winter's Landing, near river mile 708.5, appears to have the greatest potential of having been adversely affected by operation and maintenance activities. Material from the nearby upstream dredge disposal area could have been transported by wind, rain, or floods into the inlet, assisting in its partial closing. If such a relationship exists between the dredge spoil and inlet closure, dredging of the inlet might be considered as a remedial measure.

e. Expansion of dredge plant capability - The need to expand the placement capability of the dredge is not as critical to the elimination of adverse impacts in pool 7 as it is in other pools. However, in order to implement any of the alternatives which require fewer disposal sites, an expansion of the placement capability of the dredge plant is an important and necessary step. The major expansion needed would be in floating line since the most practical disposal sites are located adjacent to the main navigation channel.

f. Change water levels - Fluctuations in the water levels of pool 7 may be a desirable feature. The large shallow areas of Lake Onalaska have a high occurrence of submergent and emergent vegetation. Temporary fluctuations in the water levels during critical phases in the growth cycles of the vegetation could be used to control the type and density of the vegetative growths. Pool 7 has been operated to maintain as stable a water level as possible at the upstream side of lock and dam No. 7. Changes in water levels for vegetative growth control would probably have no noticeable effect on navigation or on operation and maintenance dredging requirements. Temporary pool raises of up to 1 foot could probably be tolerated at low flow conditions with relatively minor structural changes at lock and dam No. 7.

g. Revise locking priorities - The possible revision of locking priorities may be considered desirable at lock 7 although the current lockage priority system based on a "first come, first served" basis, would seem to be the most fair method. Several instances have arisen when recreational and commercial craft arrive at their respective approach control points at the same time, and the commercial craft received priority based on the secondary method of priority determination for lockages. During heavy recreation boating days, such as holidays and weekends, there could be certain times set up to lock only recreational craft through, such as every hour on the hour. The high number of recreation boats being locked through lock 7 makes it important to consider alternatives to current locking procedures.

h. Recreation beaches - Development of dredged spoil areas as recreation beaches would be highly desirable in pool 7. The proximity of La Crosse, combined with several locations in pool 7 conducive to heavy recreation use such as Dresbach Island and Richmond Island, indicates a need for more developed recreation facilities. A recreation demand analysis would be required prior to development of facilities, however, the potentially heavy demand could make the development of recreational beaches an important use of dredge spoil for pool 7. The sandy dredged material in this pool offers a quality recreation beach, and the water quality being suitable for water contact sports, makes these beaches even more attractive. Management of the beaches to eliminate litter would be necessary to maintain the quality of the recreation experience.

i. Wildlife habitat - Development of dredged spoil areas as wildlife habitat would also be a desirable feature in pool 7, especially in areas not subject to heavy recreation use. The areas around Winter's Landing and below Long Lake would be good areas for revegetation and development as wildlife habitat. The proximity of these areas to large expanses of floodplain forests and backwater areas would offer a good transition and buffer zone to the main channel of the Mississippi River for many species of wildlife.

6.314 Alternative plans - The major effects and impacts of implementing the alternative plans described for pool 7 are presented in Exhibit 205. The location of the selected future dredge spoil disposal sites for this pool are shown in Exhibit 219. The pertinent features of several alternative management plans for future dredge spoil activities in pool 7 are presented in the following paragraphs.

a. Status quo - Continuation of the present operation and maintenance practices in pool 7 would require dedication of at least ten areas for dredge spoil disposal covering about 170 acres. There would be little or no increases in plant capability required and no major changes in dredge spoil placement policies. Adverse environmental effects on the river systems would continue and include the direct conversion of about 155 acres of terrestrial and aquatic habitat to relatively sterile

open sand areas. An area of major concern with possible indirect movement of spoil material from the Winter's Landing area (river mile 708.5 NE) and above Dresbach (river mile 706.4 NE) into the backwater channel inlets to Lake Onalaska would still be present. The open sand areas would be available as informal recreation areas although the lack of management of these areas could have adverse effects similar to those on the present uncontrolled open sand areas. The average annual cost is approximately $31,000.

b. Selective placement - Implementation of a selective placement plan for handling of future dredged material would require a dredge plant placement capability of up to 1.7 miles, including about 1.5 miles of floating line and 0.2 miles of shorepipe. Selection and use of about four dredged material disposal areas would be necessary, covering about 160 acres. Revegetation of about 180 acres of existing and future disposal areas could reduce the loss of material to wind and rain erosion and also provide wildlife habitat. Three recreation areas could be developed on the sandy dredged disposal areas, providing an area of about 70 acres with both primitive and more highly developed recreation facilities. The recreation development potential appears to be quite desirable, especially on Dresbach and Richmond Islands, both having good access to recreational boaters. The major changes in pool 7 resulting from implementation of this plan would be a loss of about 100 acres of aquatic habitat, primarily channel border and backwater areas, and about 35 acres of open sand areas. About 135 acres of terrestrial habitat, including woodland, brush, and shrubs, would be gained. The increase in dredge plant placement capability could result in definite increases in the cost of dredging operations. However, the majority of potential adverse impacts of the operation and maintenance activities related to secondary movement of dredged material could be reduced. The potential for a small-boat harbor development at Dakota, Minnesota, could be enhanced by development of the dredged material. Increased costs for the development of recreation facilities and revegetation could be offset by the benefits attributable to recreation use and wildlife. An average annual cost of about $220,000 would be required to implement this plan in pool 7.

c. Remote disposal - Selection of two remote disposal areas for pool 7 would require about 145 acres of aquatic and terrestrial habitat. A dredge plant placement capability of about 5.1 miles would be necessary, including about 3.7 miles of floating pipe and about 1.4 miles of shorepipe. There would be several short water crossings involved in getting the shorepipe back to one of the disposal areas. There could be a net basic conversion of about 50 acres of aquatic habitat to terrestrial habitat. The aquatic habitat loss would be primarily channel border and backwater areas. Revegetation of about 225 acres of existing and future disposal would provide for reduction of material lost to wind and rain

erosion and provide additional wildlife habitat. A gain of 130 acres of woodland, brush, shrub, and grassland and a loss of 80 acres of open sand areas could be sustained. One of the disposal areas could be located remotely from the channel in a principally floodplain forest area. This type of area could introduce diversity to the terrestrial ecosystem. Recreational development on about 30 acres of the disposal areas could take place. Due to the placement locations and revegetation, secondary losses of materials should be minimal and not cause significant adverse impacts. The large amount of dredge plant capability would require major cost increases for dredging. Revegetation and recreation development would result in both tangible and intangible benefits. Aesthetics along the main river channel could be improved. Annual costs for increased plant capability, revegetation, recreation, and maintenance could exceed $370,000.

d. Central disposal - Use of one large central disposal area for future dredged material would cover about 130 acres. Dredge plant placement capability of about 6.5 miles would be needed, including about 5.5 miles of floating pipe and about 1.0 mile of shorepipe. Several water crossings would be required with the shorepipe. The major effects and impacts would consist of conversion of about 30 acres of backwater aquatic habitat to terrestrial habitat. A loss of about 90 acres of open sand areas and a gain of about 120 acres of woodland, brush, shrubs, and grasslands would result from revegetation of the dredged spoil areas. The central disposal area could be developed principally as wildlife habitat, whereas recreation facilities could be developed on about 30 acres of existing dredged spoil areas. There would be major cost increases to implement this plan due to the pumping distance requirements. Potential adverse effects due to indirect dredged material movements would be reduced. Average annual costs to implement this alternative plan would be approximately $425,000.

e. Remove from floodplain - Removal of the dredged material from the floodplain could be accomplished by development of three stockpile areas on the west side of the river channel. Development of railroad sidings or barge-loading facilities would be necessary since neither exists at suitable locations. A total of about 45 acres could be needed to handle the stockpile operations. Dredge plant capabilities to move the material about 3.0 miles would be required, essentially of floating pipe capability, as the stockpile areas are located very near the main channel. Revegetation of most existing dredge spoil areas and development of primitive-type recreation facilities on three existing spoil deposits could provide beneficial uses of the existing areas. Major effects and impacts could result in a loss of about 55 acres of open sand area and a gain of about 90 acres of woodland, brush, shrubs, and grasslands. The stockpile and loading facility areas could cause adverse aesthetic impacts along the main river channel. The closest area that would have a potential use for the material would be La Crosse, about 10 to 15 miles away by highway

or railroad. Stockpile areas would be located on the side of the main channel away from the ecologically valuable and sensitive backwater areas. The area required for the stockpiles should not increase in size beyond the initially estimated size for each site. Increased barge or railroad traffic would result from handling the material in this manner. In addition to the large cost of moving the material to the stockpile area, another large expense would be incurred by loading and unloading and transportation of the material to the final disposal area out of the floodplain. Effects and impacts at the final disposal site are not recognized here. Principal costs would involve the expansion of plant capability. Average annual costs could exceed $460,000.

POOL 8

6.315 The physical characteristics of pool 8, which are especially significant with regard to existing and future operation and maintenance activities, include the location of La Crosse, in the upper portion of the pool, and the heavy dredging requirements in the Crosby Slough and Brownsville area. Mormon Slough near river mile 694.5 is the main feeder channel for the backwaters in the Goose Island area. Crosby Slough is an important channel to the upper end of the shallow lake in the center of pool 8. The lower portion of pool 8 is a large shallow lake which is relatively open with no major above-water obstructions to flow. The heaviest and most frequent dredging requirements are in the Crosby Slough and Brownsville area, where about 70 percent of the dredging in pool 8 takes place.

6.316 Alternative measures - Recognizing these major parameters, the alternative measures which appear to offer the most practical potential for reduction of adverse environmental impacts due to operation and maintenance activities in pool 8 are: revegetation of disposal areas, selective placement, removal from floodplain, size of dredge cut, expansion of dredge capability, use as commercial commodity, development of recreation beaches, and development as wildlife habitat.

a. Revegetation - The extensive marsh and backwater slough areas in the central portion of the pool are highly productive wildlife and fisheries areas. Degradation of these areas by relatively sterile sand is not desirable. In those areas which have been affected, reintroduction of vegetation would return the area to a beneficial use for wildlife. The aesthetics along the river could be improved, especially in the Brownsville-Crosby Slough area by use of vegetative cover on the large dredge spoil areas. Although indirect secondary movement of the dredge spoil deposits do not appear to have major significance in blocking any channel inlets to backwater areas, the use of vegetation could help control secondary movement, especially above Mormon Slough where the importance of flow is recognized. Revegetation would probably not be desirable for all dredge spoil areas as many of these areas are in demand for recreation.

b. Selective placement - Use of selective placement practices combined with an increase in dredge plant capability could reduce the number of disposal sites to eight. The major effects would involve a concentration of the dredge spoil in fewer areas and away from several areas where adverse impacts from secondary movement of spoil could occur. Selective placement could result in affecting a smaller area of less valuable habitat.

c. Removal from floodplain - The high frequency and volume of dredging required near Brownsville offers an excellent potential for removal of the material from the floodplain. Barge terminals or railroad sidings do not exist there, however, a suitable area appears to be available for development of either type facility. Removal from the floodplain of the dredged material from the reach of pool 8 near Brownsville (river mile 687.7 to 691.0) could reduce future disposal area requirements in pool 8 by almost 70 percent. Material dredged at Mormon Slough (river mile 694.5) could also be removed from the floodplain by using the sand and gravel stockpile facilities of La Crosse Sand and Gravel Company, which are located within a mile of the dredge cut. Because of the long distance over land and backwater areas, special shore pipe facilities would be required. The closest area with a potential major use of the material is La Crosse, about 8 air miles from Brownsville. Removal of the dredged material from the Brownsville area might conflict with recreation development plans.

d. Size of dredge cut - There is a large volume of dredging required almost annually near Brownsville. If the depth of the dredge cut could be reduced to a minimum necessary to maintain navigation, possibly eliminating any "overdepth" dredging, the total volume of material dredged could be reduced. Caution must be exercised in the reduction of "overdepth" dredging so as not to jeopardize commercial navigation due to shoaling in the 9-foot channel.

e. Expansion of dredge capability - Although substantial reduction of adverse impacts in pool 8 would probably not result solely from increasing the placement capability of the dredge, other alternative measures may be dependent upon an increased plant capability. Some increase in plant capability would be especially desirable for the Mormon Slough and the Brownsville areas.

f. Use as commercial commodity - Although the fine sand being dredged from pool 8 does not appear to be in great demand for use as a commercial commodity, the city of La Crosse offers a potential market for the material. The proximity of the dredge cut at Mormon Slough to the La Crosse Sand and Gravel Company stockpile offers a good opportunity to test the viability of a market for the sandy dredged spoil in an urban area. The present dredge plant does not provide sufficient capability to place the material at a suitable location for use by the company. If a major economical market for the material exists in La Crosse, shipment of the material from the Brownsville dredge cut might be considered as a method of alleviating dredge spoil accumulation in the floodplain area of pool 8.

g. Development of recreation beaches - Pool 8 has a high recreational boating use as evidenced by the large number of recreation boats moored in the pool. This, combined with the many public boat launching sites and the location of La Crosse within the pool, indicates a high recreational potential for development of beach areas and facilities on dredged spoil areas.

h. Development of wildlife habitat - The dredged spoil areas between Mormon Slough and Brownsville could be revegetated and developed as wildlife habitat to complement that which currently exists in the backwaters area of the central portion of the pool.

6.317 Alternative plans - Several alternative plans that were evaluated in pool 8 for handling dredged spoil are described in the following paragraphs. More detailed information regarding the evaluation of these plans is contained in Exhibits 206 and 220.

a. Status quo - Continuation of the present operation and maintenance practices in pool 8 would require dedication of at least twelve areas for future dredged spoil, covering about 275 acres. There would probably be a conversion of about 125 acres of aquatic habitat and about 150 acres of woodland, brush, and shrub habitat into open sand areas. With little or no increases in dredge plant capability, the dredged material would continue to be placed in areas adjacent to the main channel with large accumulations of sandy dredged spoil on both sides of the main channel in the Mormon Slough, Crosby Slough, and Brownsville areas. Mormon Slough might be of concern with regard to future potential indirect movement of dredged spoil. The open sand areas would be available as informal recreation areas, although lack of management could have adverse effects similar to those present under existing conditions. The average annual cost of status quo operations would be about $50,000.

b. Selective placement - Implementation of a selective placement plan could require a dredge plant placement capability of up to about 1.7 miles, including about 1.1 miles of floating pipeline, and up to about 0.6 miles of shorepipe. About eight areas would be required for future dredged spoil material, covering about 240 acres. Recreation facilities could be developed on several dredged spoil areas, and most of the other dredged spoil areas could be revegetated. There would be about 80 acres of aquatic habitat converted to terrestrial habitat and, due to revegetation of open sand areas, a net change of about 140 acres from open sand to a grassland habitat type. Areas offering good potential locations for recreation facilities include the Brownsville area and across from Mormon Slough. Both highway access and water access would be available at the Brownsville area. Only water access would be available at the Mormon Slough area. Use of several areas off the main channel for disposal sites would not adversely affect the aesthetics along the main river channel, especially in the Crosby Slough area. The major increase

in costs would be associated with the increased plant capability. The average annual cost of implementing the selective placement alternative plan in pool 8 would be about $385,000.

c. Remote disposal - Use of four disposal sites for dredged material, covering about 225 acres, would require dredge plant placement capabilities of about 3.0 miles. The sites could be located away from the Mormon and Crosby Slough areas, reducing the probability of any indirect spoil movements into these areas. Revegetation could be used in many of the existing spoil areas and also on several of the future designated disposal areas. Recreation facilities could be developed in the Brownsville area. About 25 acres of aquatic habitat would be converted to terrestrial land areas. Revegetation of the dredged spoil areas would account for a net increase of about 190 acres of grassland habitat. The average annual cost of operation and maintenance activities would probably exceed $425,000.

d. Central disposal - A single, central disposal area for dredged material would probably best be located in the open water area east of Brownsville. An area of about 180 acres, mostly aquatic habitat, would be needed for the dredged spoil. A dredge plant placement capability of about 7.5 miles would be necessary. To accommodate the dredge pipeline into the backwater disposal area, a channel would have to be dredged. This dredging of the backwater channel would disturb natural aquatic habitat which is not accounted for in estimates of acreage needed for the central disposal alternative. Revegetation of the old and new spoil areas could result in an increase of about 340 acres of grassland, woodland, brush, and shrub areas. Recreation areas could be developed on several old spoil sites. The annual cost of implementing this alternative could be about $760,000.

e. Remove from floodplain - Use of four or five stockpile areas in pool 8 could provide convenient access to the material for removal from the floodplain. About 60 acres would be necessary in the stockpile areas to handle the dredged material. The most promising locations for these stockpile areas are at Brownsville and near the south edge of La Crosse. Both locations would involve rather short pumping distances for the large volumes of material to be handled from the nearby dredging cuts. About 15 acres of aquatic habitat would be converted to terrestrial habitat. Recreation areas could be developed near Brownsville and Crosby Slough. Revegetation could increase the area of grassland in pool 8 by about 125 acres. The cost of removing the material from the floodplain would be about $812,000 per year.

POOL 9

6.318 Several of the characteristics of pool 9 that were utilized in the consideration of alternatives would be significant in any future efforts in this pool. The following are examples of some of the more important characteristics of pool 9.

6.319 Pool 9 is the second largest pool in the St. Paul District. Two small tributary rivers flow into the Mississippi in pool 9 - the Bad Axe River, entering from Wisconsin, and the Upper Iowa River, entering from Iowa. There are no signs of glacial action in the high bluff areas of pool 9, but lowland and floodplain areas include alluvial terraces formed by glacial streams. Blackhawk Memorial Park and Battle Island are two important historical areas. Circulation in the backwaters, sloughs, and marshes is critical to the maintenance of high quality habitat which sustains the rich fish and wildlife resources of this pool. The two most important cities contributing to local recreation use of pool 10 are Lansing and New Albin, Iowa. Major dredging areas in the future are estimated to be at the following locations: river miles 663.5 - 666.0, 667.5, 671.0 - 672.0, 674.5, and 677.5.

6.320 Alternative measures - Recognizing the above considerations, the alternative measures which appear to offer the most practical potential for reduction of adverse environmental impacts related to future operation and maintenance activities in pool 9 are: revegetation of disposal areas, selective placement, dredge openings into backwaters, expansion of dredge plant capability, development of recreation beaches, and development of wildlife habitat. The relative significance of each alternative measure for pool 9 is discussed in the following paragraphs.

a. Revegetation - The wildlife values of the backwater areas in pool 9 are relatively high. Replacement of these areas with a nonproductive sand tends to degrade the value of the entire system to wildlife. Revegetation could assist in stabilizing the material, reclaiming areas for wildlife use, and enhancing the natural aspects of the area. Between river miles 663.5 and 667.0 there are six major openings to backwater channels and side channels. Secondary movement of spoil within or upstream of this area could be particularly damaging due to the potential for closing off these openings. Revegetation of many of the disposal areas, especially large areas and those upstream from the channels into backwaters would help to reduce any indirect spoil movements and reestablish a valuable wildlife habitat. Revegetation of all areas would probably not be desirable as use of the sandy areas for recreation beaches is quite heavy. However, revegetation of many of the spoil sites would improve the aesthetic value of the view along the river. The attractiveness of the area in general is dependent on the "naturalness" of the landscape. Bare, conical areas are a constant reminder of human activity and partial revegetation would probably enhance these areas.

b. Selective placement - Ten locations were chosen as possible disposal sites for the alternative measure of selective placement. The center of each site is located not more than one-half of a mile from the centerline of the channel. An increase in plant capability would be required with this alternative. Five of the sites are located along the edge of the main channel within easy access by recreational watercraft. It is

anticipated that these areas would receive heavy recreation use. The remaining sites are located on both sides of the main channel but back in the floodplain forest a short distance and would have value for recreation and wildlife habitat.

c. Expansion of dredge capability - An expansion of the placement capability of the dredge plant is an important and necessary step in order to implement any of the alternatives which require fewer areas designated as disposal sites. The major expansion capability needed would be in floating line, as the most practical disposal sites are located adjacent to the main navigation channel. If dredged materials could be placed on a minimum of sites or removed far enough away from the main channel, many of the adverse impacts inherent to the present spoil disposal methods could be reduced or eliminated. For example, the total acreage of spoil sites could be reduced, spoil could be placed in areas of lower biological sensitivity, and stabilization and aesthetic enhancement as a result of vegetation methods could have an opportunity to alleviate the adverse effects of spoil deposition.

d. Dredge openings into backwaters - There are six openings to major circulation channels between river miles 663.5 and 667.0. Any secondary movement of dredge spoil material within or upstream of this area could be particularly damaging due to the potential for closing off these openings. The exact status of these circulation channels is not presently known due to a lack of depth and current measurements. The present status of these circulation channels, the degree of circulation necessary to maintain a healthy backwater environment, and the relationship, if any, between the operations and maintenance activity of the 9-foot channel and the occlusion of these circulation channels is not presently known. If a relationship exists between the dredge spoil and possible inlet closure, dredging of the inlet might be considered as a remedial measure.

e. Wildlife habitat - Development of dredged spoil areas as wildlife habitat would be a desirable feature in pool 9, especially in areas not subject to heavy recreation use. The reclamation of spoil sites into productive wildlife areas would probably be somewhat competitive with the development of spoil areas for recreation. However, significant changes in the quality of wildlife habitat might be apparent if the problem was examined in terms of creating nontypical sites. Smaller islands along heavily dredged areas could be planted with grass species to encourage waterfowl nesting. Larger islands might benefit from an increased habitat diversity. For example, a site located in an extensive area of floodplain forest could be planted in grassland or brushland types.

f. Recreation beaches - Dredged materials could be used to replenish existing beach areas which for one reason or another have lost a degree

of desirability. Reasons for this loss could be attributable to natural plant succession, erosion, or intensive recreational use and accumulation of litter. New beaches could also be created in areas where they are lacking or where existing beaches receive greater than normal use. Creation of more off-channel sites might be considered desirable if more seclusion enhances their recreation potential. In all instances, careful consideration should be given to possibilities of serious erosion or inaccessibility.

A recreation demand analysis would be required prior to development of facilities. The analysis would determine the acreage needed for recreational use including developed sites and overflow areas. The sandy dredged material in this pool offers a quality recreation beach, and the water quality being suitable for water contact sports makes these beaches even more attractive. Management of the beaches to eliminate litter, etc., would be necessary to maintain the quality of the recreation experience.

6.321 Alternative plans - The major effects and impacts of implementing the alternative plans described for pool 9 are presented in Exhibit 207. The locations of the selected future dredge spoil disposal sites for each alternative plan for this pool are shown in Exhibit 221. Alternative plans applicable to pool 9 and aspects pertinent to each are as follows:

a. Status quo - The continuation of the present operation and maintenance practices in pool 9 would require dedication of at least 14 areas for dredge spoil disposal covering about 215 acres, in addition to the 205 acres utilized at present. There would be little or no increase in plant capability required and no major change in dredge spoil placement policies. Adverse environmental effects on the river systems would continue and include the direct conversion of about 95 acres of terrestrial habitat and 120 acres of aquatic habitat to relatively sterile open sand areas.

Effects of water and wind erosion could probably cause secondary movements back into the channel area and some degree of adverse effects could be expected in backwater sloughs and openings. An area of concern with regard to possible indirect movement of spoil material after placement is the area between river miles 663.5 and 667.0. In this area there are several openings to backwater channels and side channels which lead into the Winneshiek Slough-Lafayette Slough area on the east side of the main channel and to the Big Lake area on the west side of the main channel. Any secondary movement of spoil in this area might contribute to the closing off of these channels. The open sand areas in the pool would be available as informal recreation areas; however, lack of management of these areas could have adverse effects similar to those on the existing uncontrolled open sand areas. Adverage annual costs are approximately $38,000.

b. Selective placement - Implementation of a selective placement plan for handling future dredged material would require a dredge plant placement capability of up to about 2.0 miles. Selection and use of about nine spoil disposal areas would be necessary, covering about 190 new acres.

A plan of allocation for recreational or wildlife uses could result in converting disposal sites into open sand areas to provide primitive and more highly developed recreational facilities or revegetation to provide wildlife habitat. The major changes in pool 9 resulting from implementation of this plan would be a loss of about 75 acres of aquatic habitat, primarily backwater areas. Terrestrial habitat could increase by 75 acres, possibly with 50 percent devoted to grassland and 50 percent planted to woodland brush and shrubs.

The increase in dredge plant placement capability could result in definite increases in the cost of dredging operations, however, the majority of potential adverse impacts of the operation and maintenance activities related to secondary movement of dredged material could be reduced. Increased costs for the development of recreation facilities and revegetation could be offset by the benefits attributable to recreation use and wildlife.

One 45-acre site southeast of river mile 665.0 is located on the north side of Highway 62 and would provide a good potential for development for intensive recreational uses. Total annual costs to increase plant capability and revegetate could exceed $350,000.

c. Remote disposal - In pool 9 there are six sites that could have reasonably good potential for consideration as future disposal areas for the alternative plan of remote disposal. Rather extensive increases in dredge plant capability would be required. A total placement capability of about 2.1 miles would be necessary.

In addition to the existing 205 acres, the remote disposal alternative could require an additional 185 acres placed in six locations. One of these sites is located adjacent to the main channel at river mile 654.0. This 5-acre island could be utilized as a nesting site by waterfowl if planted with grasses. The remaining sites are located off to the side of the main channel usually a moderate distance back into the adjacent floodplain forest and backwaters. Two of these sites involve rather large acreages and would have good potential for development as wildlife habitat. The large 80-acre site at river mile 665.5 could have some recreational development adjacent to the main channel, and the remaining acreage could be revegetated to provide wildlife habitat and reduce the effects of erosion.

The expanded dredge plant capability necessary with this alternative plan would require major cost increases for dredging. Revegetation and recreation development would result in both tangible and intangible

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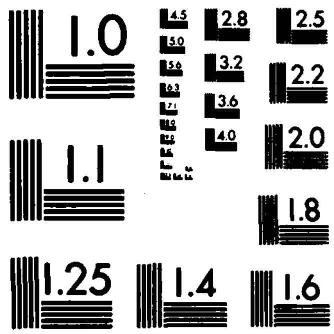

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benefits. Aesthetics along the main river channel could be improved. The total average annual cost to implement this alternative would exceed $360,000.

d. Central disposal - A large central disposal area for future dredged material would cover about 140 acres. Dredge plant placement capability of about 9.7 miles would be needed, including about 8.0 miles of floating pipe and about 1.7 miles of shorepipe. There would be major cost increases to implement this plan due to the pumping distance requirements. Therefore, it might be more practical to consider barging as a method of moving the spoil for this alternative.

The principal loss of habitat could occur among the floodplain forest types. Few aquatic habitat types would be affected and no potential dangers could be foreseen as a result of secondary movements due to wind or water erosion. Grassland types could realize the largest gain in acreage if revegetated areas were planted in grassland and woodland brush and shrubs on an equal acreage allotment. The site does not have highway or boat access, therefore, the area could probably best be developed for wildlife habitat. Average annual costs to implement this alternative plan in pool 9 would be approximately $715,000.

e. Remove from floodplain - Five sites of approximately 10 acres each could be designated as stockpile areas for both barge and railroad pickup. An expansion of plant capability of 2.7 miles would be necessary. Development of railroad sidings or barge-loading facilities would be necessary as none currently exist in suitable locations. A total of about 40 acres could be needed for the stockpile operations. The stockpile and loading facility areas could cause adverse aesthetic impacts along the main river channel. Since only stockpile areas are considered, this alternative plan would require the least floodplain acreage dedicated for future dredge spoil. Stockpile areas would be located on the side of the main channel away from the ecologically valuable and sensitive backwater areas. The area required for the stockpiles should not increase in size beyond that initially estimated. Increased barge or railroad traffic would be a result of handling the material in this manner. In addition to the cost of moving the material to the stockpile area, another barge expense would be incurred by loading and unloading and transportation of the material to the final disposal area out of the floodplain. Effects and impacts at the final disposal site are not recognized here.

Revegetation and development of primitive-type recreation facilities could provide beneficial uses of existing spoil deposits. Major effects and impacts would include a loss of about 20 acres of aquatic habitat and a gain of about 20 acres of woodland, brush, and grassland. The large increase in natural habitat would be the result of revegetation efforts on 125 acres of existing open sand areas. The revegetation of existing disposal areas could reduce the loss of material to wind and rain erosion and also provide wildlife habitat.

In this pool it was possible to locate the stockpile areas within a moderate distance of the areas of heavy dredging. Therefore, the initial movement of spoil from dredge cut to stockpile area would not be as costly as in some other pools in the St. Paul District. Average annual costs of this plan would be about $550,000.

POOL 10

6.322 There are several characteristics of pool 10 that are unique and were important in the consideration of alternatives. This long narrow pool has expansive slough and marsh development and is a rich habitat for fish and wildlife. The expances of open water characteristic of the upper pools are minimal in this pool. There is marsh habitat to within 4 miles of dam No. 10. Circulation channels and inlets are critical to the maintenance of the high biological value of sloughs and riverine lakes and ponds. The Wisconsin River merges with the Mississippi River in pool 10. The Wisconsin River carries a sediment load which is 30 percent greater than that of the Chippewa River, however, due to a number of hydrologic and geologic factors most of this sediment is washed past dam No. 10. The two most important cities contributing to local recreation use of pool 10 are Prairie du Chien, Wisconsin, and Guttenberg, Iowa. Effigy Mounds National Monument, McGregor State Park, and Pike's Peak State Park are important existing developed recreation areas. The major dredging areas in the future are estimated to be near the following locations: river miles 619.0, 627.5, 643.0, 644.5, and 646.5.

6.323 <u>Alternative measures</u> - The alternative measures which appear to offer the most practical potential for reduction of adverse environmental impacts related to future operation and maintenance activities in pool 10 are: revegetation of disposal area , selective placement, dredge openings into backwaters, expansion of dredge plant capability, change control plant in pool, revise locking priorities, development of recreation beaches, and development of wildlife habitat. The relative significance of each alternative measure for pool 10 is discussed in the following paragraphs.

a. Revegetation - The wildlife values of the backwater areas in pool 10 are relatively high. Replacement of these areas with a non-productive sand tends to degrade the value of the system to wildlife. Revegetation could assist in stabilizing the material, reclaiming areas for wildlife use, and enhancing the natural aspects of the area. There are two open sand disposal areas located directly upstream of a gut at river mile 627.9. Any possible secondary movement of sand from these areas has potential for closing off the gut. In pool 10 there are no other particularly sensitive areas that appear to be threatened by secondary movement of dredge spoil. Revegetation of many of the disposal areas, especially large areas and those upstream of the channels into backwaters would help to reduce any

indirect spoil movements and would help reestablish a valuable wildlife habitat. Revegetation of all areas would probably not be desirable as use of the sandy areas for recreation beaches is quite heavy. However, revegetation of many of the spoil sites would improve the natural aesthetic value of the view along the river. The attractiveness of the area in general is dependent on the "naturalness" of the landscape. Bare, conical areas are a constant reminder of human activity and partial revegetation would probably enhance these areas.

b. Selective placement - Six locations were chosen as possible disposal sites for the alternative plan of selective placement. The center of each site is located less than one-half mile from the centerline of the channel. An increase in plant capability would be required with this alternative. Potential sites would not pose a problem to backwater channel openings and all of the sites could be within easy access to the main routes of recreational watercraft. Two of the sites are located along the water's edge, but separated from the main channel. These sites are at McMillan Island, river mile 618.0, and McGregor Lake, river mile 633.7. It is anticipated that these areas would receive heavy recreational use.

Dredged spoil placed in these areas would have very little potential for causing any indirect adverse impacts. If any material would be lost due to secondary movement, it would probably go back into the navigation channel. These areas are located relatively close to the major dredging areas in the pool and the increase in dredge plant capability that would be required would not impose impossible restraints on the dredging activities.

c. Expansion of dredge capability - An expansion of the placement capability of the dredge plant is an important and necessary step in order to implement any of the alternatives which require fewer disposal sites. The major expansion capability would be in floating line, as the most practical disposal sites are located adjacent to the main navigation channel. If dredged materials could be placed on a minimum of sites or removed far enough away from the main channel many of the adverse impacts inherent to the present spoil disposal methods could be reduced or eliminated. For example, the total acreage of spoil sites could be reduced, spoil could be replaced in areas of lower biological sensitivity, and stabilization and aesthetic enhancement as a result of revegetation could alleviate the adverse effects of spoil deposition.

d. Change the control point - This measure as applicable to pool 10 would involve redesigning the operating plan for the pool which would bring it into conformity with the other pools in the St. Paul District. Shifting of the primary control point to Clayton, Iowa, and the resulting relative stabilization of water levels in the Clayton-Bagley-Frenchtown Lake region would do much to alleviate the problems of water fluctuation in the midpool area. However, it must

be realized that this measure would result in a trade off, because the relocation of the primary control point to Clayton would result in a longer period of drawdown in the lower portion of pool 10.

e. Wildlife habitat - Developments of dredged spoil areas as wildlife habitat would be a desirable feature in pool 10, especially in areas not subject to heavy recreation use. The reclamation of spoil sites into productive wildlife areas would probably be somewhat competitive with the development of spoil areas for recreation, although the acreage claimed for recreational use would be dependent upon the demand.

Significant changes in the quality of wildlife habitat might be achieved by using dredge spoil to create nontypical sites. For example, smaller islands along heavily dredged areas could be planted with grass species to encourage waterfowl nesting. Larger islands might benefit from an increase in habitat diversity. For instance, a site located in an extensive area of floodplain forest could be planted in grassland or brushland types. This side-by-side existence of two habitats results in an edge effect important to wildlife preservation and production.

Two large current spoil disposal areas appear to have high potential for development as good wildlife habitat. The locations are at river miles 644.7 and 643.0. The proximity of these areas to large expanses of floodplain forests and backwater areas makes the possibility of establishing nontypical sites very desirable. The resulting creation of ecotone or "edge effect" would enhance the area for wildlife.

f. Recreation beaches - Dredged materials could be used to replenish existing beach areas which for one reason or another, have lost a degree of desirability. Reasons for this loss could be attributable to natural plant succession, erosion, or entensive recreational use and accumulation of litter. New beaches could be created in areas where they are lacking or where existing beaches receive greater than normal use. Creation of more off-channel sites might be considered desirable if more seclusion enhances their recreation potential. In all instances, careful consideration should be given to possibilities of serious erosion or inaccessibility.

A recreation demand analysis would be required prior to development of facilities. The analysis would determine the acreage needed for recreational use including developed sites and overflow areas. The sandy dredged material in this pool offers a quality recreation beach, and the water quality being suitable for water contact sports, makes these beaches even more attractive. Management of the beaches to eliminate litter, etc., would be necessary to maintain the quality of the recreation experience.

6.324 <u>Alternative plans</u> - Alternative plans applicable to pool 10 and aspects pertinent to each are described in the following paragraphs. The major effects and impacts as well as the amounts and locations of dredged spoil materials are presented in Exhibits 208 and 222, respectively.

a. Status quo - The future continuation of the present operation and maintenance practices in pool 10 would require dedication of at least twelve areas for dredge spoil disposal covering about 140 acres, in addition to the 130 acres utilized at the present. There would probably be no increase in plant capability required and no major changes in dredge spoil placement policies. Adverse environmental effects on the river systems would continue and include the direct conversion of about 80 acres of terrestrial habitat and 45 acres of aquatic habitat to relatively sterile open sand areas.

Effects of water and wind erosion could cause secondary movements back into the channel area and some degree of adverse effects could be expected in backwater sloughs and openings. An area of concern with regard to possible indirect movement of spoil material after placement, is the spoil disposal area on the islands east of Wyalusing, Wisconsin (river mile 628.0). This location is upstream of a relatively important circulation channel and any secondary movement of spoil might contribute to the closing off of the channel. The open sand areas in the pool would be available as informal recreation areas, although lack of management could have adverse effects similar to those on the present uncontrolled open sand areas. Annual costs would be approximately $25,000.

b. Selective placement - Implementation of a selective placement plan for handling of future dredged material would require a dredge plant placement capability of up to 1.7 miles, including about 1.5 miles of floating line and 0.2 miles of shorepipe. Selection and use of about six spoil disposal areas covering about 110 acres would be necessary.

A plan of allocation for recreational or wildlife uses could result in converting disposal sites into open sand areas to provide primitive and more highly developed recreation facilities or revegetation to provide wildlife habitat. The major changes in pool 10 resulting from implementation of this plan would be a loss of about 20 acres of aquatic habitat, primarily channel border. Terrestrial habitat could increase 20 acres possibly with 50 percent devoted to grassland and 50 percent planted to woodland brush and shrubs.

The increase in dredge plant placement capability would result in definite increases in the cost of dredging operations, however, the majority of potential adverse impacts of the operation and maintenance activities related to secondary movement of dredged material could be reduced. Increased costs for the development of recreation facilities and revegetation could be offset by the benefits attributable to recreation use and wildlife. Average annual costs due to implementation of this alternative plan could exceed $200,000.

c. Remote disposal - In pool 10 there are four sites that have reasonably good potential for consideration as future disposal areas

for the alternative plan of remote disposal. It is recognized that rather extensive increases in dredge plant capability would be required. A total placement capability of 2.3 miles would be necessary, including about 2.0 miles of floating pipe and 0.3 miles of shore pipe.

In addition to the existing 130 acres, the remote disposal alternative could require an additional 100 acres placed in four locations on both sides of the navigation channel. Two of these sites are located along the edges of riverine lakes at Frenchtown Lake, river mile 619.0, and at McGregor Lake, river mile 633.7. These two areas could provide high quality recreation beaches in the future unless the adverse impacts proved to be greater than anticipated. A third site could be located about one-half mile southwest of river mile 627.3. This location is north of Methodist Lake, east of Magill Creek, and just south of the unnamed gut running into Johnson Slough. This location has potential for recreation and wildlife habitat. The fourth site could be located about 0.3 miles west of river mile 644.3. Both of the last two proposed sites could be partially revegetated to provide wildlife habitat and reduce the effects of water and wind erosion. The unvegetated area could provide open sand areas for recreational use. The potential for intensive recreational use is possible in both areas as they are large enough to warrant development of sanitary facilities, nature trails, or boat launching facilities. Both areas also offer boat access from nearby waterways, however, the gut just north of the fourth site may require some deepening.

A gain of 55 acres of terrestrial habitat and the loss of 40 acres of open sand areas could be obtained with this plan. One of the disposal areas could be located remotely from the channel in a principally floodplain forest area. In this location, diversity to the terrestrial ecosystem could be introduced by applying the non-typical site plan discussed earlier. Recreational development on about 80 acres of the disposal areas could be attained. Due to the placement locations and revegetation, secondary and indirect losses of materials would be minimal and not cause significant adverse impacts. The expanded dredge plant capability would require major cost increases for dredging. Revegetation and recreation development would result in both tangible and intangible benefits. Aesthetics along the main river channel could be improved. Average annual costs to implement this alternative plan for pool 10 would be approximately $230,000.

d. Central disposal - Use of one large central disposal area for future dredged material would cover about 90 acres. Dredge plant placement capability of about 10 miles would be needed. There would be major cost increases to implement this plan due to the pumping distance requirements. Rehandling of the material from the distant points in the pool would be necessary.

The principal loss of habitat could occur among the floodplain forest types. Little if any aquatic habitat types would be affected and no potential dangers would be foreseen as a result of secondary movements due to wind or water erosion. Grassland types could represent the largest gain in acreage if revegetated areas were planted in

grassland and woodland brush and shrubs on an equal acreage allotment. A portion of the disposal site facing the main channel and within a reasonable distance to boat access could remain unvegetated and provide an area for development of recreational facilities. The average annual costs for implementing this alternative plan would be about $564,000.

e. Remove from floodplain - Five sites of approximately 10 acres each could be designated as stockpile areas for either barge or railroad pickup. An expansion of plant capability of 2.3 miles would be necessary and could consist of 0.3 miles of shorepipe and 2.0 miles of floating pipe.

Development of railroad sidings or barge-loading facilities would be necessary since none currently exist in suitable locations. Loading facilities would also be required at each site. A total of about 45 acres would be needed to handle the stockpile operations. The stockpile and loading facility areas could cause adverse aesthetic impacts along the main river channel. The floodplain acreage dedicated for future dredge spoil is the least with this alternative plan as only stockpile areas are considered. Stockpile areas would be located on the side of the main channel away from the ecologically valuable and sensitive backwater areas. The area required for the stockpile sites should not increase in size beyond the initially estimated area for each site. Increased barge or railroad traffic would result from handling the material in this manner. In addition to the cost of moving the material to the stockpile area, another large expense would be incurred in loading, unloading, and transporting the material to the final disposal area out of the floodplain. Effects and impacts at the final disposal site are not recognized here.

Revegetation and development of primitive-type recreation facilities could provide beneficial uses of the existing spoil deposits. Major effects and impacts would consist of a loss of about 5 acres of aquatic habitat and a gain of about 30 acres of woodland, brush, and grasslands. The large increase in natural habitat is the result of revegetation efforts on 25 acres of open sand areas. The revegetation of existing disposal areas could reduce the loss of material to wind and rain erosion and also provide wildlife habitat.

In this pool it is possible to locate stockpile sites within a moderate distance of areas of heavy dredging. Therefore, the initial movement of spoil from dredge cut to stockpile area would not be as costly as in many of the other pools in the St. Paul District. The main factor restricting the applicability of this plan would be the apparent lack of a viable market for the spoil within a reasonable distance of the stockpile areas. Average annual costs for implementation of this alternative plan in pool 10 would exceed $365,000.

SUMMARY OF ALTERNATIVES

6.325 The reasonable alternatives considered, both measures and plans, have varying degrees of effectiveness in alleviating the adverse environmental impacts of the present operation and maintenance of the 9-foot navigation channel. The alternative measures consist of actions taken to alleviate individual or specific adverse environmental impacts, whereas the alternative plans consist of a combination of several alternative measures used to alleviate the majority of the adverse impacts within a given pool.

6.326 The alternative measures, as described and discussed in general for the 9-foot channel in the St. Paul District and on an individual pool basis, could have significant potential for reduction of adverse impacts. The identification of those alternative measures which have the greatest potential for alleviation of the adverse impacts on an individual pool basis are summarized in Exhibit 223. The measures which had this potential in the greatest number of pools included:

a. Selective placement

b. Revegetation

c. Development of recreation facilities

Those measures which had this potential in several pools included:

a. Development of wildlife habitat

b. Increase dredge plant capability

c. Commercial use

d. Remove from floodplain

e. Remote disposal

f. Dredge openings into backwaters

g. Size of dredge cut

h. Revise locking priorities

i. Change water levels in pools

Those measures which had this potential in the fewest number of pools or in only isolated cases included:

a. Watershed land treatment

b. Sediment deposition control structures

c. Type of dredge

d. Change control point in pool

e. Confined disposal

f. Shore protection of disposal areas

g. Central disposal

h. Cutterhead

i. Provide fish passageways

j. Provide low flow outlets

k. Provide other passages for recreation craft

The value of an alternative measure in alleviating adverse impacts is not necessarily illustrated by the above tabulation. However, this list might be used as a guide in selecting those measures which might best be considered for the entire system. Some alternative measures have only limited applicability, however, where they are applicable, they may play a very important role in the alleviation of adverse impacts.

6.327 In addition to their potential for alleviating adverse impacts, the status of the measures must also be considered on an authority, justification and funding basis. The status of each measure as to the existing Congressional authority for implementation is summarized in Exhibit 224. Those alternative measures which are not covered under existing Congressional authorities include:

a. Sediment deposition control structures

b. Change water levels

c. Provide other passages for recreation craft

6.328 The alternative measures of shore protection for disposal areas, confined disposal, and dredging of openings into backwater areas fall under the category of questionable status of authority. The existing legislation and subsequent interpretations do not specifically include or exclude these measures. Shore protection, however, may be justified and authorized in some isolated cases depending on the circumstances. All of the other measures have general Congressional authority, and their implementation would depend on their justification and the availability of funding. All Federal agencies operate under certain policies and guidelines which govern their specific actions. The dredging activities of the St. Paul District are accomplished in compliance with the Corps

of Engineers Regulation 1130-2-307, "Project Operation: Dredging Policies and Practices," dated 31 October 1968 and other regulations as appropriate. In addition to operating under these regulations, the St. Paul District must also operate within the funding it receives for completion of its assigned tasks. One of the overriding factors of operating within the above regulations is a Congressionally-imposed moratorium on the purchase of additional dredging equipment. Other legislation and agency policies govern the justification and implementation of other measures such as watershed land treatment and development of recreation facilities.

6.329 Further consideration should be given to any alternative measure before it is recommended for implementation. In most cases, at least some additional study would be required in order to determine where, to what degree, and how the measure should be implemented in order to assure that the maximum public benefit is derived. In some cases, the actual feasibility and/or the specific impacts and effects of an alternative measure would have to be determined by a detailed study.

6.330 The alternative plans, as described and discussed in general and on an individual pool basis, were evaluated in terms of their major impacts and effects. A summary evaluation of the impacts and effects of these alternative plans as applied throughout the St. Paul District is presented in Exhibit 225. The major impacts and effects of the alternative plans evaluation as estimated for the next 50 years show that:

a. The status quo plan would require an annual expenditure of about $740,000, at a unit cost of about $0.50 per cubic yard. About 2,705 acres of natural wildlife habitat, including about 1,135 acres of aquatic habitat, would be converted into open sand areas. Natural revegetation processes would occur to varying degrees on some of the open sand areas.

b. The selective placement plan would require an annual expenditure of about $3,670,000, including about $640,000 for revegetation and recreation development. The unit cost of material handled would be about $2.45 per cubic yard. There would be a net change of about 910 acres of aquatic habitat to terrestrial habitat. Mainly through the revegetation process, about 595 acres would be changed from open sand areas to terrestrial wildlife habitat. Recreation use opportunities would be expanded through the provision of developed recreation areas. About 80 acres of open sand area could be developed for industrial purposes.

c. The remote disposal plan would require an annual expenditure of about $5,260,000, including about $610,000 for revegetation and recreation development. The unit cost of material handled would be about $3.50 per cubic yard. There would be a net change of about 735 acres of aquatic habitat to terrestrial habitat. Revegetation techniques would be responsible for a net change of about 910 acres from open sand into terrestrial

wildlife habitat. About 40 acres of agricultural land would be affected, and about 100 acres of open sand area would be available for industrial development. Additional recreation facilities would be developed to offer more recreation opportunities.

d. The central disposal plan would require an annual expenditure of about $8,950,000, including about $550,000 for revegetation and recreation development. The unit cost of material handled would be about $5.95 per cubic yard. There would be a net change of about 595 acres of aquatic habitat to terrestrial habitat. Revegetation would account for a net conversion of about 790 acres of open sand to wildlife habitat. About 150 acres would be available for industrial development. Additional recreation facilities would also be provided.

e. The remove from the floodplain plan would require an annual expenditure of about $8,120,000, including about $370,000 for revegetation and recreation development. The unit cost of the material handled would be about $5.40 per cubic yard. This includes a cost for trucking the material to a hypothetical final disposal site within about 25 miles of the stockpile area but does not include any land costs at the disposal site. About 175 acres of aquatic habitat would be converted to terrestrial habitat in the form of open sand stockpile areas. Revegetation would be responsible for a net change of about 865 acres of open sand areas to wildlife habitat. Additional recreation facilities would also be provided. The land use and habitat changes outside the floodplain area, in the final disposal site, are not accounted for in this evaluation, but should also be considered in the evaluation of net impacts.

6.331 The major annual expenditure increases in the alternative plans were associated with the increase in dredge plant capability. The revegetation and recreation development costs were only a small (4 to 17 percent) part of the total annual costs. The major direct habitat and land use changes were more a function of the revegetation and recreation developments than the actual placement capability of the dredge, except in the case of removal from the floodplain where the final utilization sites were not included in the evaluation. If suitable disposal sites could be found in non-floodplain areas where the wildlife habitat or other environmentally sensitive systems would not be affected, then the remove from the floodplain plan would be the only plan where the significant land use and habitat changes would be attributable primarily to the increase in dredge plant capability.

6.332 The estimated acreage required for future dredge spoil placement for each alternative plan is given for each pool and also for all pools in Exhibit 226. The major differences in the area requirements stem from the use of different numbers of disposal sites, except for the remove from the floodplain plan where the acreage required at the final disposal site is not included.

6.333 These alternative plans were evaluated to give a relative perspective to the concepts that were considered, proposed, or promulgated by various interests and concerns. The reasonability of implementing any of these plans was not used as a qualification for their evaluation, but rather their evaluation should offer the specific information necessary to judge the relative merits of each plan.

6.334 The feasibility or constraints under which each plan could be implemented are very similar to those for the alternative measures. The basic Congressional authority exists for implementation of any of the plans. However, the qualifications and criteria of availability of funds, the feasibility of the plan, modifications to agency policy and exceptions to a Congressional moratorium would be the limiting factors on implementing any of the alternative plans, except status quo. The status quo plan currently has Congressional authority, is within agency policy, and is being funded.

SECTION 7

7. The Relationship Between Local Short-Term Uses of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity

7.01 The purpose of this section is to assess the cumulative and long-term impacts of the operation and maintenance of the 9-foot channel with the view that each generation is a trustee of the environment to succeeding generations.

7.02 The continued operation and maintenance of the 9-foot navigation channel contributes to the long-term productivity of the area by permitting the economic advantages of low-cost waterborne transportation. The importance of the Upper Mississippi River as a major transportation artery for bulk commodities, particularly those having low value-to-weight ratios is recognized. Coal, petroleum, and grain have these characteristics and are examples of such commodities that originate, terminate or move through the St. Paul District's pools on river barges. The efficiency of waterborne transportation will probably foster the continued or expanded economic development of cities and industry along the Upper Mississippi River.

7.03 Since the initial construction of the project, the operation and maintenance of the 9-foot channel has sustained many beneficial short-term uses of the river environment. The resulting water complex is considered a high value recreation area and has provided boating, fishing, camping, swimming, hunting, waterskiing, picnicking, and sightseeing for millions of people. The maintenance of authorized water surface elevations greatly increases habitat for many species of fish and wildlife. The marshes and lakes host thousands of birds on a twice-yearly migration, permitting the public great opportunities to enjoy them on a consumptive or non-consumptive basis.

7.04 However, the continued high biological productivity of this area is being threatened. Continuing sedimentation is filling lakes and marshes and obstructing boat travel in the backwaters. Sedimentation is a natural process that has been aggravated by dam operation and dredging activity. At present little information is available as to the exact relationship between present operation and maintenance activities and naturally occurring sedimentation in the backwaters of the river.

7.05 Recently, increased attention has been given to the role of sediment as a carrier of plant nutrients, pesticides and toxic elements. Research indicates that clay minerals such as those found in river sediment have active surfaces that react with an array of chemical compounds. These compounds may be concentrated in the sediment over a period of years and then redistributed during a high-flow period. Plant nutrients such as nitrogen, phosphorous, potassium, and certain trace elements (micronutrients) are adsorbed on sediments and may have biological significance in the eutrophication of ponds, reservoirs and lakes.

7.06 The present least cost method of spoil disposal has resulted in losses of acreage of productive fish and wildlife habitat. These losses can be attributed to both the direct effects of initial spoil placement and the indirect effects resulting from secondary movement of the spoil after it has been placed.

7.07 Disposal of dredged material *within time* and on a cumulative basis may alter the physiographic character of the Upper Mississippi River. This process in some cases has led to a "channelization effect." Spoil placement often results in the conversion of fish and wildlife habitat into relatively biological sterile open sand areas.

7.08 Secondary movement of spoil can contribute to the occlusion of backwater circulation channels. If backwater circulation is impaired, the water velocity is decreased resulting in increased sedimentation in backwater parts of the floodplain. Backwater circulation is also necessary to prevent stagnation conditions.

7.09 Fish, wildlife, and recreation interests are deeply concerned about the possible implication of eroded dredge spoil in the blockage of the entrances of flowing sloughs. The fish and wildlife interests have pointed out that extensive shallow aquatic backwater habitats depend upon flowing sloughs for supplies of fresh, oxygenated water and for the flushing of dissolved nutrients.

Without the freshening and flushing, backwater systems tend to stagnate. This reduces the production of desirable sport fish, the potential for use by migrating waterfowl, the production of food and house-building materials for furbearing semiaquatic mammals, and the quality of the aesthetic setting. Recreation boaters have noted also that the blockage of the sloughs reduces boating access.

7.10 The intrinsic value of the Mississippi River wetlands, sloughs, and backwater areas will probably increase as the process of sedimentation gradually reduces the availability of these habitats in the future.

SECTION 8

8. Irreversible and Irretrievable Commitments of Resources

8.01 This section discusses any irrevocable uses of resources, changes in land use, destruction of archaeological or historical sites, unalterable disruptions in the ecosystem and other adverse environmental effects that would result should the present method of operation and maintenance continue. Also included are possible indirect actions that would cause changes in land and water use that could not be halted or reversed under free enterprise principles.

8.02 Resources committed for operation and maintenance of the 9-foot channel in the past are, for the most part, irretrievable and irreversible. However, some materials could be used for other purposes or recycled and, therefore, are not totally irretrievable. Habitat losses could be mitigated by commitment of additional resources for restoration. The magnitude of resources required in a restoration effort is variable and in those instances where costs exceed benefits, the effects of environmental degradation are considered irreversible. Under the existing method of operation and maintenance, irreversible and irretrievable commitments of resources will continue in the future. These specific commitments are discussed below.

8.03 Quantifiable costs incurred in operation and maintenance of the 9-foot navigation channel are those for labor and materials. A labor force is required for dredging operations as well as operating the lock and dam structures. Minor amounts of materials such as lumber, paint, limestone rubble and metal are used for maintenance and repair of existing facilities.

8.04 Operation and maintenance of the locks and dams requires a work force of 153 full-time personnel. An additional 29 personnel are required on a seasonal basis during the peak summer navigation period. Operation of the structures during fiscal year 1973 required approximately 460,000 kilowatt hours of electricity and approximately 2,500 gallons of fossil fuels. The total cost for operation of the locks and dams in fiscal year 1973 was approximately $4,177,300.

8.05 Present dredging operations employ approximately 66 personnel on the Dredge WILLIAM A. THOMPSON and 33 on the DERRICKBARGE HAUSER. A reduced crew is maintained on board the DERRICKBARGE HAUSER during weekends and on both barges during winter months. Operating costs for a 7-day work period during fiscal year 1973 were $40,600 for the WILLIAM A. THOMPSON and $21,350 for the DERRICKBARGE HAUSER. The WILLIAM A. THOMPSON uses about 340,000 gallons of No. 2 diesel fuel per year, while the DERRICKBARGE HAUSER uses about 25,000 gallons per year. In addition to operating costs, annual channel condition surveys are performed at an estimated cost of $90,000. Total costs for dredging activities, including administration and District Office overhead and survey work averaged about $1 million per year between 1969 and 1973.

8.06 The loss of native terrestrial vegetation as a result of dredge spoil deposition is irreversible and essentially irretrievable. Continued disposal on terrestrial sites will result in a decreasing proportion of available wildlife habitat. Should the spoil site be revegetated immediately, the structure and species composition of the original plant community could not be duplicated and the resultant vegetative cover would probably differ markedly. Natural plant succession would eventually replace the original community with one that is reflective of new environmental conditions such as less moisture. However, the required number of years would be greater than the span of most men's lives. Alteration of a "natural river" has undeniably occurred and can be considered a loss to future generations under present operation and maintenance procedures. It is possible, however, that some semblance of a natural river could be regained. This would require that lock and dam structures remain open year-round or that all devices originally constructed for the 9-foot channel project be removed. Obviously, this would result in the loss of the the navigation system and the benefits occurring from low-cost waterway transportation.

8.07 Dredged spoil material placed in an aquatic area results in both irreversible and occasional irretrievable losses. Aquatic vegetation, invertebrates, mollusks, and arthropods could be buried and smothered. Their actual loss is irretrievable but new colonization on submerged dredged material may eventually modify the loss.

8.08 Development of recreational, commercial, industrial and residential facilities is indirectly encouraged by operation and maintenance of the system. Therefore, the trend toward development can be considered irreversible under the authorities of present legislation. At the very least, recreational use is encouraged by the presence and addition of beaches with a potential for development of toilets and concessions. Residential, commercial and industrial developments result from the economic advantages associated with the low-cost waterway transportation system.

8.09 Although the dynamics of sedimentation in the river system are largely unknown, it is generally assumed that filling in of the floodplain and raising of the entire valley floor by sedimentation is an irreversible trend in the current geologic era. Reduction of velocity in the lower end of the pools and in backwater areas as a result of natural or unnatural blockage of entrances to backwaters reduces the competency and capacity in both the river and its tributaries. A trade-off then exists where a loss of water volume and associated aquatic habitat types is replaced by a gain of land area and its associated terrestrial type of habitat.

8.10 Previous sections discussed the effects upon archaeological and historic sites resulting from construction of the 9-foot channel. Based on available information, the present method of operation and maintenance has not and is not expected to result in the destruction of any archaeological or historic sites.

SECTION 9

9. Coordination

9.01 Coordination and public participation conducted during the preparation of the Environmental Impact Statement include contracted environmental impact assessment studies, meetings and workshops with various interests and agencies, public meetings, and other coordination with governmental agencies, citizen groups, conservation interests, and business interests.

9.02 The environmental impact assessment studies conducted by North Star Research Institute under contract with the St. Paul District Corps of Engineers were used as the primary source of information for this statement. The assessment studies were prepared for each individual pool and navigable tributary river reach for the entire section of the Mississippi River 9-foot channel project within the St. Paul District. North Star Research Institute subcontracted with several college and university investigators to prepare assessment reports in various pools. The availability and distribution of these assessment reports is discussed in the foreword to this Environmental Impact Statement.

9.03 In addition to the extensive coordination conducted by North Star Research Institute, a letter of coordination (Exhibit 232) was sent to over 160 individuals and representatives of State and Federal agencies, transportation and transportation-dependent interests, conservation and wildlife organizations, and environmental and other citizen groups.

9.04 Several informal coordination meetings were held with two of the principal investigators associated with the environmental impact assessment study. Similar meetings were held with representatives of the Bureau of Sport Fisheries and Wildlife, and Soil Conservation Service. The methodology being used in the preparation of the Environmental Impact Statement and an exchange of information concerning the impacts, effects, and applicability of the various alternatives being considered were the principal topics of discussion.

9.05 A coordination meeting was held with the Wisconsin Department of Natural Resources to discuss the preparation and format of this Environmental Impact Statement. Their views concerning the authorization limits of the 9-foot channel project; the various alternatives being considered, especially removal from the floodplain; and the adverse environmental impacts being caused by dredging activities were also discussed.

9.06 Public meetings in conjunction with the preparation of this Environmental Impact Statement on the operation and maintenance of the 9-foot navigation channel were held at St. Paul, Minnesota and La Crosse, Wisconsin on 17 and 18 June 1974, respectively. The principal intent of these meetings was to allow the general public, as well as other interests, an opportunity to comment on the operation and maintenance activities associated with the 9-foot channel project, and more specifically on the information contained in the draft Environmental Impact Statement. Transcripts of these public meetings are available upon request at the St. Paul District Office.

9.07 Other coordination conducted in conjunction with the preparation of the Environmental Impact Statement and/or with the normal operation and maintenance activities of the 9-foot channel project include meetings held with: the Federal Executive Board of the Twin Cities, the Minneapolis Grain Exchange, the Upper Mississippi River Basin Commission, and Upper Mississippi River Conservation Committee.

9.08 Letters of coordination, as shown in Exhibit 232, were sent to the State Historical Society of Minnesota, the State Historical Society of Wisconsin, and the U. S. Department of the Interior, National Park Service. In addition, during the preparation of the environmental impact assessment study, North Star Research Institute contacted the State Historical Societies and State Archaeologists of Iowa, Minnesota, and Wisconsin. Correspondence to North Star Research Institute from the State Historical Society of Wisconsin, the State Historic Preservation Officer of Iowa, and the State Archaeologist of Iowa are attached as Exhibits 233 to 235, respectively. Correspondence from the State Historical Society of Wisconsin to the District Engineer is attached as Exhibit 236.

9.09 The draft statement was furnished to the following agencies and interested citizens for review and comment.

Hon. Richard C. Clark, U. S. Senate
Hon. Harold E. Hughes, U. S. Senate
Hon. Hubert H. Humphrey, U. S. Senate
Hon. Walter F. Mondale, U. S. Senate
Hon. Gaylord A. Nelson, U. S. Senate
Hon. Wm. S. Proxmire, U. S. Senate
Hon. Bob Bergland, Representative in Congress
Hon. John A. Blatnik, Representative in Congress
Hon. John C. Culver, Representative in Congress
Hon. Donald M. Fraser, Representative in Congress

Hon. Bill Frenzel, Representative in Congress
Hon. Harold V. Froehlich, Representative in Congress
Hon. H. R. Gross, Representative in Congress
Hon. Joseph E. Karth, Representative in Congress
Hon. Robert W. Kastenmeier, Representative in Congress
Hon. Wiley R. Mayne, Representative in Congress
Hon. Ancher Nelsen, Representative in Congress
Hon. David R. Obey, Representative in Congress
Hon. Albert H. Quie, Representative in Congress
Hon. William A. Steiger, Representative in Congress
Hon. Vernon W. Thomson, Representative in Congress
Hon. John M. Zach, Representative in Congress
U. S. Department of Agriculture
U. S. Department of Commerce
U. S. Department of Health, Education and Welfare
U. S. Department of Housing and Urban Development
U. S. Department of the Interior
U. S. Department of Transportation
U. S. Environmental Protection Agency
U. S. Federal Power Commission
Water Resources Council
Upper Mississippi River Conservation Committee
Upper Mississippi River Basin Commission
Upper Mississippi River Wildlife and Fish Refuge
Minnesota-Wisconsin Boundary Area Commission
U. S. Army Waterways Experiment Station, Vicksburg, Mississippi
Hon. Wendell Anderson, Governor, Minnesota
Hon. Patrick J. Lucey, Governor, Wisconsin
Hon. Robert D. Ray, Governor, Iowa
Minnesota Department of Agriculture
Minnesota Department of Economic Development
Minnesota Department of Health
Minnesota Department of Natural Resources
Minnesota Environmental Quality Council
Minnesota Historical Society
Minnesota Pollution Control Agency
Minnesota Railroad and Warehouse Commission
Minnesota Resource Commission
Minnesota State Archaeologist
Minnesota State Historical Society
Minnesota State Park Commission
Minnesota State Planning Agency
Minnesota Water Resources Board
Minneapolis Department of Public Works
Minneapolis Traffic Association, Director of Traffic
St. Paul Port Authority
Iowa Department of Environmental Quality
Iowa Historic Sites Preservation Program, State Liaison Officer

Iowa State Archaeologist
Iowa State Conservation Commission
Iowa State Planning Division
Iowa Water Pollution Control Commission
Wisconsin Department of Natural Resources
Wisconsin Board of Agriculture
Wisconsin State Board of Health
Wisconsin Department of Administration
Mississippi River Regional Planning Commission, La Crosse, Wisconsin
Natural Resources Council of State Agencies, Water Committee
Wisconsin Soil Conservation Board
Wisconsin Department of Transportation
State Historical Society of Wisconsin
Citizens Advisory Committee, Environmental Quality Council, St. Paul
Conservation Federation, Washington, D.C.
Environmental Division, Hennepin County, Hopkins
Friends of the Earth, St. Paul
Friends of the Earth, Washington, D.C.
Iowa Wildlife Federation, Ames, Iowa
Izaak Walton League of America, Environmental Affairs Director
Izaak Walton League of America, Iowa Division
Izaak Walton League of America, Minnesota Division
Izaak Walton League of America, Wisconsin Division
League of Women Voters, Iowa
League of Women Voters, Minnesota
League of Women Voters, Wisconsin
Metropolitan Council, St. Paul
Minnesota Conservation Federation
Minnesota Environmental Control Citizens Association, Chairman
Mississippi Watershed Task Force
Minnesota Land Use Coalition, St. Paul
Minnesota Public Interests Research Group, Minneapolis
Mississippi Gorge Association, Minneapolis
Mississippi Valley Association, Omaha, Nebraska
Mississippi Valley Association, St. Louis, Missouri
National Association of River and Harbor Contractors, Washington, D.C.
National Audubon Society
National Audubon Society, North Midwest Regional Office, Red Wing, Minnesota
National Wildlife Federation, Midwestern Field Representative
Natural Resources Defense Council, Washington, D.C.
The Nature Conservancy, Iowa Chapter, Waterloo
Northern Environmental Council, Wisconsin
River and Harbor Improvement Association, Milwaukee
Sierra Club, John Muir Chapter
Sierra Club, Midwest Representative
Sierra Club, North Star Chapter
Soil Conservation Society of America, Minnesota Chapter, Willmar
Southwestern Wisconsin Regional Planning Commission, Wisconsin State University, Platteville
Upper Mississippi Waterway Association, Minneapolis

Water Resources Council, Omaha
West Wisconsin Regional Planning Commission, Eau Claire
Wildlife Management Institute, Washington, D.C.
Wildlife Society, Washington, D.C.
Wisconsin Society of Professional Engineers, Madison
Wisconsin Society of Professional Engineers, Western Chapter, La Crosse
Lockmaster, Upper & Lower St. Anthony Falls, Mr. Harold French
Lockmaster, Lock & Dam 1, Mr. Alfred H. Mathews
Lockmaster, Lock & Dam 2, Mr. Glen J. Duren
Lockmaster, Lock & Dam 3, Mr. Harold E. Traister
Lockmaster, Lock & Dam 4, Mr. Owen j. Wanek
Lockmaster, Lock & Dam 5, Mr. Irvin E. Kerkenbush
Lockmaster, Lock & Dam 5A, Mr. Wallace J. Voss
Lockmaster, Lock & Dam 6, Mr. Lester C. Leavitt
Lockmaster, Lock & Dam 7, Mr. Burton F. Morris
Lockmaster, Lock & Dam 8, Mr. Raymond E. McLees
Lockmaster, Lock & Dam 9, Mr. Carl D. Noel
Lockmaster, Lock & Dam 10, Mr. Burnell L. Reinitz
Message Center, Lock & Dam 2, Mr. Robert A. Classen & Mr. Sheldon Fox
ADM-American River Transportation Company, Mr. John E. Harvey
Aiple Towing, Incorporated, Mr. Frank Aiple
A. Kertzman Dredging Company, Mr. A. Kertzman
Alexander and Alexander Incorporated, Marine Insurance Department
Allied Structural Steel Company, Mr. A. A. Schlin, Jr.
AMAX Coal Company, Mr. John H. Fuller
American Commercial Barge, Mr. Jim Buky
American Commercial Barge Line Company, Mr. J. D. Wafford
American Hoist and Derrick, Mr. Frank Doherty
American Iron and Supply Company, Mr. Fred Isaacs
American River Transportation Company, Mr. Neville Stone
American Technical Assistance Corporation
Arrow Transportation Company, Mr. William K. Nestor
Association of American Railroads, District Manager
Association of American Railroads, Chairman, Zone and Committee on Waterway Projects
Avondale Shipyards, Incorporated, Mr. Charles Smallwood
B & M Towing Company, Mr. R. C. Meyer
Biscoe Transfer, Mr. Robert Biscoe
Bunge Corporation, Mr. Duane F. Stich
Burlington Northern, Incorporated, Mr. Bruce C. Anderson
Mr. George Burden
Mr. Stuart S. Byrne
C & F Industries, Incorporated, Mr. Greg Langenfeld
The C & O/B & O Railroads, Mr. R. C. Tranch
Capitol Barge Services, Incorporated, Mr. Robert Draine
Central Soya Company, Mr. W. J. Schnide, Jr.
Chicago & North Western Railroad Company, Mr. B. R. Meyers

Chicago & North Western Railroad Company, Mr. D. E. Oakleaf
Chicago, Milwaukee, St. Paul & Pacific Railroad, Mr. B. J. Worley
Chicago, Milwaukee, St. Paul & Pacific Railroad, Mr. L. B. Horton
Chicago, Rock Island & Pacific Railroad, Chief Engineer
Clinton Development Company, Mr. Harold L. Kirk
Continental Grain Company, Mr. Norton Quarve
Cook Industries, Incorporated, Mr. J. C. Campbell
Dairyland Power Cooperative, General Manager
Dravo Corporation, Marine Sales Department
Dubuque Dock Commission, Mr. Vincent I. Kaiser
Dundee Cement Company, Traffic Manager
Eastern Iowa Light and Power Cooperative, Mr. Earl Jarvis
Farmland Industries, Incorporated, Mr. Charles W. Bath
Farmers Union Central, Mr. Clarence Anderson
Farmers Union Grain Terminal, Mr. M. J. Werner
Federal Barge Lines, Incorporated, Mr. J. F. Lynch
General Mills, Incorporated, Mr. R. L. Steele
Mr. H. L. Goodell, Consulting Engineer
George Lloyd Levin, Incorporated, Mr. George L. Levin
Industrial Molasses Company, Mr. Richard R. Lacy
Ingram Barge Company, Mr. John M. Donnelly
Interstate Power Company, Mr. Robert W. Steele
J. D. Cayton Towing Service, Incorporated, Mr. J. D. Cayton
J. L. Shiely Company, Incorporated, Mr. Joseph L. Shiely, Jr.
John W. Gorman, Incorporated, Mr. John W. Gorman
KGW Towing Company, Mr. G. C. Weathers, Jr.
Koch Industries, Incorporated, Traffic Manager
Kujak Brothers Transfer, Mr. Martin Kujak
La Crosse Dredging Company
Linwood Stone Products Company, Mr. John F. McDonnell
Marine Dravo Corporation, Midwestern Sales Manager
Martin Marine Contractors, Mr. A. D. Martin, Jr.
Martin Marietta Cement, Mr. Edmund Seyfried, Jr.
McKee Feed and Grain Company, Mr. Harold G. McKee
McMillan Company, Mr. Manuel F. Blanco, Jr.
Mid-America Transportation, Captain Willard B. Fouts
Midwest Towing Company, Incorporated, Operations Manager
Minneapolis Grain Exchange, Director of Transportation
Minneapolis, Northfield & Southern Railroad, General Manager
Minnesota Department of Business Development
Minnesota Harbor Service, General Manager
Moline Consumers Company, Mr. James O. Ellis
National Marine Service, Incorporated, President
Mr. Robert Niemeyer
Northeast Mo. Electric Power Cooperative, General Manager
Northern States Power Company, Mr. Gary V. Welk, Minneapolis, Minnesota
Northern Waterway Terminals Corporation, Mr. T. E. Burken, Clinton, Iowa

Northern Waterway Terminals, President, Minneapolis, Minnesota
Pillsbury Company, Mr. A. P. McIntosh
Port Authority of City of Winona
Port City Barge Line, Incorporated, Mr. J. W. Baskir
Pullman Banking Group, Mr. Richard Burda
Sahara Coal Company, Incorporated, Mr. E. B. Lux, Monroe, Wisconsin
Sahara Coal Company, Incorporated, Mr. Harry Eggert, Chicago, Illinois
S. B. Foot Tanning Company, Mr. E. H. Foot, Jr.
Soo Line Railroad Company, Chief Engineer
St. Croix Towing Company, Mr. Robert Maher
Twin City Barge & Towing Company, Mr. John W. Lambert
Upper Mississippi Towing Company, Mr. G. M. Chapman
Upper Mississippi River Corporation, Mr. John Beacom
The Valley Line Company, Mr. W. J. Barta, President, St. Louis, Missouri
The Valley Line Company, Mr. Lynn Childs, Chicago, Illinois
Western Railroad Association, General Solicitor
Wisconsin Barge Line, Incorporated, Mr. Ray Eckstein
Zeigler Coal Company, Mr. Scott M. Rogers
Dr. David E. Behin, Director, Institute for Environmental Studies St. Louis University
Dr. Paul B. Kannowski, Director, Institute for Ecological Studies University of North Dakota
Minnesota Environmental Education Steering Committee, Minnesota Department of Education
River Bend Association, Water Resources Development Commission, Gustavus Adolphus College
River Studies Research Group, University of Wisconsin, La Crosse
Water Resources Research Center, University of Minnesota
Dr. Daniel E. Willard, Institute for Environmental Studies, University of Wisconsin, Madison
Mr. Rudie Baack
Mr. Jock Forintine
Mr. Robert F. Nelson
Mr. Alfred E. Pease
Mr. Thomas Poirier
Mr. Glen Skovholt
Mr. James Svore
Mr. Alden Thomas
Mr. Dean H. Lenz
Mr. Roscoe Colingsworth
Mr. Eugene Erickson
Mrs. Barbara Gudmundson
Mr. Edward Miller
Mr. Calvin Fremling
Mr. Thomas Claflin
Mr. James Eckblad
Mr. Edward Cawley
Mr. Donald Gray

9.10 In addition, informational copies of the draft were furnished to the following libraries where they are available for public review.

Minnesota

Cannon Falls, Public Library, Cannon Falls
Environmental Library of Minnesota, Minneapolis
Hastings Public Library, Hastings
Hill Reference Library, St. Paul
Lake City Public Library, Lake City
Mankato State College, Mankato
Minneapolis Public library, Minneapolis
Red Wing Public Library, Red Wing
Rochester Public Library, Rochester
St. Paul Public Library, St. Paul
St. Mary's College, Winona
University of Minnesota, Minneapolis
University of Minnesota, St. Paul
Winona Public Library, Winona
Winona State College, Winona

Wisconsin

Eau Claire Public Library, Eau Claire
Hudson Public Library, Hudson
La Crosse Public Library, La Crosse
Mabel Tainter Memorial Library, Menomonie
Madison Public Library, Madison
Platteville Public Library, Platteville
Prairie du Chien Public Library, Prairie du Chien
River Falls Public Library, River Falls
Stout State University, Menomonie
University of Wisconsin, Madison
Wisconsin State University - Eau Claire, Eau Claire
Wisconsin State University - La Crosse, La Crosse
Wisconsin State University - Platteville, Platteville
Wisconsin State University - River Falls, River Falls
Viroqua Public Library, Viroqua

Iowa

Carnegie Stout Library, Dubuque
Clark College, Dubuque
Decorah Public Library, Decorah
Loras College, Dubuque
Luther College, Decorah
McGregor Public Library, McGregor
University of Dubuque, Dubuque
Upper Iowa University, Fayette

North & South Dakota

Carnegie Library, Pierre, South Dakota
North Dakota State University, Fargo, North Dakota
South Dakota State University, Brookings, South Dakota
University of North Dakota, Grand Forks, North Dakota
University of South Dakota, Vermillion, South Dakota

COMMENT - RESPONSE

9.11 Comments on the draft Environmental Impact Statement from various groups, agencies, individuals, and special interests have been incorporated into the final statement as appropriate. The views expressed concerning the environmental effects of the action have been set forth in a "comment" and appropriately discussed in a "response". Similar comments are consolidated to avoid duplication, but the source of the comments is identified. In the interest of brevity and clarity: (1) the comments and responses are arranged in the same order in which the subjects appeared in the main body of the draft statement, (2) the comments are consolidated into one when several interested parties addressed the same point, and (3) the interests making the comment are identified by an identification number given in parenthesis preceding the comment. A list of those groups, agencies, individuals, and special interests which commented on the draft statement follows, with the identification number and the exhibit number (as listed in the EXHIBITS text) on which that interest's full letter can be found. Note that the page and section numbers referred to in the comments by the various interests apply to the draft statement only. The page and section numbers used in the final statement are different from the draft and an additional section, "Relationship of the Action to Land Use Plans", has been added to the final statement.

9.12 Letters of comment on the draft statement were received as noted in the following list. Also included in the list are the identification number and exhibit number assigned to each letter of comment.

Identification Number	Letter of Comment	Exhibit Number
1	U.S. Environmental Protection Agency	237
2	U.S. Department of Agriculture - Forest Service	238
3	U.S. Department of Agriculture - Soil Conservation Service	239
4	U.S. Department of Commerce	240
5	U.S. Department of Housing & Urban Development	241
6	U.S. Department of the Interior	242
7	U.S. Department of Transportation	243

Identification Number	Letter of Comment	Exhibit Number
8	U.S. Department of Transportation, U.S. Coast Guard	244
9	Federal Power Commission	245
10	Minnesota-Wisconsin Boundary Area Commission	246
11	Minnesota Department of Natural Resources	247
12	Minnesota Pollution Control Agency	248
13	Minnesota Historical Society	249
14	Iowa State Conservation Commission - 1 April 1974	250
15	Iowa State Conservation Commission - 15 April 1974	251
16	Iowa State Conservation Commission - 8 May 1974	252
17	Wisconsin Department of Natural Resources - 5 April 1974	253
18	Wisconsin Department of Natural Resources - 23 April 1974	254
19	Wisconsin Department of Transportation	255
20	Metropolitan Council of the Twin Cities Area	256
21	Saint Paul City Council	257
22	Port Authority of Saint Paul	258
23	Crawford County Board, State of Wisconsin	259
24	Izaak Walton League of America, Midwest Region	260
25	Izaak Walton League of America, 7 May 1974	261
26	Minnesota Environmental Control Citizens Association	262
27	Sierra Club	263
28	South East Minnesota Area - Wide Planning Organization	264
29	Wisconsin Society of Professional Engineers	265
30	American Trucking Association, Inc.	266
31	H.L. Goodell, Consulting Engineer	267
32	John W. Gorman, Inc.	268
33	Minneapolis Grain Exchange	269
34	Missouri Pacific Railroad Company	270

Identification Number	Letter of Comment	Exhibit Number
35	Northern States Power Company	271
36	North Star Research & Development Institute	272
37	Sahara Coal Company	273
38	St. Paul Ammonia Products, Inc.	274
39	Twin City Barge & Towing Company	275
40	Western Railroad Traffic Association	276
41	Environmental Research Center, Loras College	277
42	The Waterways Journal	278

9.13 A Statement of Findings has been prepared for distribution with the final Environmental Impact Statement and includes recommendations for future action.

9.14 The final Environmental Impact Statement is distributed to all agencies and interests who have submitted comments on the draft statement as noted in the preceding list. In addition, the following agencies and individuals also receive copies of the final statement.

Hon. Richard C. Clark, U.S. Senate
Hon. Harold E. Hughes, U.S. Senate
Hon. Hubert H. Humphrey, U.S. Senate
Hon. Walter F. Mondale, U.S. Senate
Hon. Gaylord Nelson, U.S. Senate
Hon. Wm. S. Proxmire, U.S. Senate
Hon. Bob Bergland, Representative in Congress
Hon. John A. Blatnik, Representative in Congress
Hon. John C. Culver, Representative in Congress
Hon. Donald M. Fraser, Representative in Congress
Hon. Bill Frenzel, Representative in Congress
Hon. Harold V. Froehlich, Representative in Congress
Hon. H. R. Gross, Representative in Congress
Hon. Joseph E. Karth, Representative in Congress
Hon. Robert W. Kastenmeier, Representative in Congress
Hon. Wiley R. Mayne, Representative in Congress
Hon. Ancher Nelsen, Representative in Congress
Hon. David R. Obey, Representative in Congress
Hon. Albert H. Quie, Representative in Congress
Hon. William A. Steiger, Representative in Congress
Hon. Vernon W. Thomson, Representative in Congress
Hon. John M. Zwach, Representative in Congress
Hon. Wendell Anderson, Governor, Minnesota
Hon. Patrick J. Lucey, Governor, Wisconsin
Hon. Robert D. Ray, Governor, Iowa
Judge James E. Doyle, U.S. District Court, Western District of Wisconsin

U.S. Department of Health, Education and Welfare
U.S. Army Engineer District, Louisville
U.S. Army Engineer District, Rock Island
U.S. Army Engineer District, St. Louis
U.S. Army Engineer Institute for Water Resources
Board of Engineers for Rivers and Harbors
State Historical Society of Wisconsin
Upper Mississippi River Wildlife and Fish Refuge
Upper Mississippi River Basin Commission
Upper Mississippi River Conservation Committee
Dr. Thomas Claflin, University of Wisconsin-La Crosse
Dr. James Cooper, University of Minnesota
Dr. Calvin Fremling, Winona State College
Hastings Public Library
Minneapolis Public Library
Red Wing Public Library
Rochester Public Library
St. Paul Public Library
University of Minnesota, University Libraries
Winona Public Library
La Crosse Public Library
Prairie du Chien Public Library
University of Wisconsin-Madison, Memorial Library
University of Wisconsin-La Crosse, Library

9.15 The following text consists of the "Comment - Response" portion of the Environmental Impact Statement described in the preceding paragraphs.

SUMMARY

Comment (12): The Summary should be modified to follow the format specified in APPENDIX I, CEQ GUIDELINES, FEDERAL REGISTER, VOL. 38, NO. 147, August 1, 1973, on the following points:

(a) The name, address, and telephone number of the individual at the agency who can be contacted for additional information about the proposed action or the statement should be provided.

(b) Under "Description of Major Federal Action," the States particularly affected and the other proposed Federal actions in the area which are discussed in the statement should be indicated.

(c) The date the draft and final statements were made available to CEQ and public should be added.

Response: The referenced revisions have been incorporated in the final Environmental Impact Statement (EIS).

Comment (12): Page xi(3a)- "Estimates of savings in transportation costs" attributed to the continued O&M of the 9-foot channel project is not a proper subject for this Summary statement on environmental impacts and should be eliminated.

Response: Current guidelines require that this section include economic and social effects as well as environmental effects. Therefore, the savings in transportation costs attributed to the O&M of the 9-foot channel project is a proper subject for the Summary statement and is retained.

Comment (40): On pages xi, 177 and 278 of the draft EIS, the statement is made that navigation on the Upper Mississippi River results in savings in transportation costs for bulk commodities of between 4.0 and 5.4 mills per ton-mile over the least-cost alternative mode of transportation. These statements are incorrect to the extent that wherever the word "cost" appears, it should be replaced by the word "rate." The reference for these rate savings estimates is page J-90 in Appendix J of the 1970 Upper Mississippi River Comprehensive Basin Study. On page J-90 it is clearly indicated that these values of 4.0 to 5.4 mills per ton-mile were based on rate analyses developed for the Corps by Charles Donley and Associates, Pittsburgh, Pennsylvania.

Response: The text of the final EIS has been revised in the appropriate places to more clearly indicate that these estimates are based on a comparison of rates.

Comment (4,6,10,11,18,28): On page xi(3a) of the draft EIS it is stated that "The aesthetics of the present river setting and the production of fish and wildlife are dependent upon the continued operation and maintenance of the project."

We question the statement in that there is no doubt that present aesthetics and fauna production are affected by the project. They are, by no means, dependent upon the continued operation and maintenance. River Valley aesthetics are a combination of natural and man-made factors. In addition aesthetics is a qualitative judgement. For some, the project may be an attraction; to others it may well detract from the maximum aesthetic value. While there is reason to believe that the project has aided in fish and wildlife production, and increased habitat area, this production, per se, is not dependent upon continued operation and maintenance of the 9-foot channel.

Response: The referenced portion of the Summary has been revised in the final EIS. However, no implications are made as to the positive or negative views of various individuals toward the aesthetics of the present river setting. The operation and maintenance of the 9-foot channel project is essential to maintenance of the pools and as such is instrumental to maintaining the present river setting and its associated characteristics.

Comment (10,41): Page xi(3a)- The placement of maintenance dredge spoil does not inevitably require that "aquatic and semi-aquatic habitats adjacent to the navigation channel be converted to sandy islands..." This erroneously infers that there is no other way to dispose of the spoil, even under present capabilities. Instead, the EIS should acknowledge that the current practice of placing spoil adjacent to the channel causes such habitats to be converted to sandy islands. Such islands do not "tend to eventually develop typical bottomland vegetation."

Response: The subject sentence has been modified as follows: "The current placement of maintenance dredge spoil requires that aquatic, semi-aquatic and terrestrial habitats adjacent to the navigation channel be converted to sandy islands which tend to eventually develop vegetation." Page xi of the final EIS.

Comment (6,18): Spoils sites may eventually revegetate in a period of decades; however, this revegetation may not necessarily result in the development of a "typical" bottomland forest containing such species as swamp white oak, ash, or silver maple. The frequency of deposition and its initial erosive character prevents revegetation on many important spoil areas.

Response: See previous Comment/Response.

Comment (6,10,11,18): Although there is heavy recreational activity on some spoil sites, others have such steeply eroded banks or have such high piles of spoil material that recreational use is discouraged. Campers, swimmers, picnickers, and boaters tend to utilize spoil deposit sites that are closer to the main channel. Those spoil sites which have resulted in the covering of backwater areas or which have resulted in the killing of overstory vegetation frequently are not used by recreationists.

Response: Comment noted.

Comment (12): Use of spoil sites as wildlife habitat is so limited that we question its inclusion as a summary statement.

Response: The sentence states that "The spoil sites also support some use . . ." which is believed to be more accurate than stating that it receives no use. Furthermore, its inclusion in the Summary is not believed to detract from the section but rather to add to its completeness.

Comment (12,18): Turtles undoubtedly nest on spoil areas but there is no evidence that turtle populations have shown significant increases as a result of dredging or that a lack of nesting sites were a limiting factor to turtle production in the past. If turtle numbers have increased with dredging, it is questionable whether more turtles justify fewer bass, bluegills, muskrats, and ducks.

Response: Comment noted.

Comment (10,18): Page xi(3b)- Unavoidable loss of aquatic habitat by present methods of placement is not limited to "areas adjacent to the navigation channel." For example, blockage of flow in backwater areas is frequently influenced directly by initial placement of spoil or by location of spoil piles which later erode and cause blockage. Increased siltation reduces the depth of backwater areas and leads to stagnation with an eventual loss of aquatic habitat.

Response: The information presented in the Summary section is believed to be adequate for the purpose intended for the section. Additional discussion of these issues are found in the Environmental Impact section of the EIS.

Comment (18): It should be clarified that "The placement of spoil frequently affects submerged wing and closing dams which provide excellent habitat for the production of aquatic invertebrates and fish."

Response: Concur. The word "submerged" has been added in the final EIS on page xii.

Comment (12): Page xii(3b)- Turbidity caused by dredging also destroys fish eggs or retards their hatching.

Response: Subject information included on page xii of the final EIS.

Comment (12): Page xii(3b)- Reference to adverse effects on terrestrial vegetation and wildlife should be added.

Response: The subject sentence was modified to state the following: "The present method of dredge spoil placement results in the unavoidable loss of aquatic and terrestrial habitat in areas adjacent to the navigation channel and subsequent displacement of associated wildlife " on page xii of the final EIS.

Comment (12): Page xii- The visual or aesthetic qualities of an area are as much a part of the "environment" as the physical resources. Therefore, the adverse environmental impacts on the total aesthetics of the area should be considered and described. What does the sight of dredge spoil do to someone seeking a natural setting? Obvious evidence of man's alteration of and intrusion in primarily natural areas has a definite adverse impact on the aesthetic values of those areas.

Response: The deposition of dredge spoil undoubtedly affects the aesthetics of the river environment; whether this impact should be considered adverse or not is dependent upon individual interpretation. Many people feel that the recreational beaches resulting from spoil deposition are aesthetically pleasing. The referenced topic has been included in the Summary section of the final EIS.

Comment (12): Page xii(4c)- All "alternative actions" listed are not alternatives. Some are alternatives and others are complementary measures which might reduce adverse impacts.

Response: The alternatives listed do include complementary measures to reduce adverse impacts associated with O&M activities. However, a complementary measure can be considered as an alternative measure to some aspect of the existing O&M activities if it is not currently practiced or practiced only to a limited degree.

DESCRIPTION OF MAJOR FEDERAL ACTION

Comment (20): There is a major omission in the project description. There is no definition of the objectives of the project. There is no discussion of the underlying purpose of the project, nor is a need for the project demonstrated anywhere in the document. These data are necessary to the decision making process for they provide the basis for judging the impacts and alternatives.

Response: This Environmental Impact Statement is on the operation and maintenance of the 9-foot navigation channel project, and not on the 9-foot navigation channel itself. The objectives and underlying purpose of the project as related to this statement are covered in the Environmental Setting, under "The 9-Foot Channel Controversy," pages 110 to 115 of the final EIS.

Comment (20): A minor point in the project description section is that the study area is not clearly delineated--neither verbally nor graphically.

Response: The study area is described in both paragraph 1.05 and Exhibit 1.

Comment (10): More information on wing dam and closure dam numbers, types, locations, purpose and their effects on operation of 9-foot channel and environmental effects should be presented in *this section*.

Response: The primary purpose of the wing dam and closure dams was not for operation and maintenance of the 9-foot navigation channel. The number and location of these structures are illustrated on Exhibits 34 to 42. Additional information concerning the types and purposes of the structures is available in the St. Paul District office. Although some studies have been made at specific locations concerning the possible effects of wing and closure dams on the operation and maintenance of the 9-foot channel, no studies have been made on the effects of these structures on the overall 9-foot channel system, and no additional information was provided in the final EIS on these structures.

Comment (18): Page 3, First Sentence - It is our opinion that the inland waterway system should be considered as a part of a total integrated transportation system including all modes of transportation.

Response: The project description is specifically referring to the integration of the 9-foot channel within the St. Paul District to the remainder of the inland waterway transportation system. This integration

is one of the most vital links to the commerce which is carried on the Upper Mississippi River 9-foot channel system. Other modes of transportation are also important to the waterway as connecting systems and as competition. The relationship of the other modes of transportation to the waterway system is difficult to present for only the St. Paul District portion of the 9-foot channel system as the cargo carried usually has either its point of origin or destination outside the St. Paul District. If the entire 9-foot channel system or inland waterway navigation system for the Mississippi River were studied, this would be an appropriate point to consider.

Comment (3): Exhibits 1 and 31 - Prairie du Chein should read Prairie du Chien.

Response: Concur. These plates have been printed in final form prior to identification of the error. To conserve taxpayer money, the reprinting of these plates to correct this error will not be undertaken.

Comment (10): Page 6, First Paragraph, Second Sentence - Although the locks and dams were originally constructed for commercial navigation purposes, it should also be pointed out that the project is a multi-purpose development, and that the recreational values of the Mississippi River are of considerable economic benefit.

Response: The primary authorizing purpose of the project was commercial navigation. Other uses, including the recreation values of the Mississippi River, have subsequently developed on the River and are discussed in the Environmental Setting section of the EIS.

Comment (26): Page 8, Paragraph 2- Explain how lack of need was determined.

Response: The referenced statement has been revised on page 6 of the final EIS.

Comment (18): Page 9, First Paragraph, Last Sentence - Although the operation and maintenance of the 9-foot channel project has been tacitly approved by Congress for the past thirty-five years, we wonder why Congress has not also been informed of the need for a change in dredge spoil disposal methods and the need for fish and wildlife enhancement.

Response: The Corps of Engineers, as authorized by Congress in the National Environmental Policy Act of 1969, is in the process of carrying out its obligations and responsibilities to determine the impacts and effects of the operation and maintenance of the 9-foot channel system by preparing this

Environmental Impact Statement. The conclusion of this impact statement, the Statement of Findings, summarizes the significant results of the study and discusses the need for additional study or proposed changes in current operation and maintenance practices as appropriate. Congress will be informed of the environmental impacts of the 9-foot channel and the needed changes.

The Corps of Engineers does not have authority over all activities that are under public control on the Upper Mississippi River. Other State and Federal agencies each have specific delegated responsibilities to perform.

Comment (10): Page 9 - Certainly Congress has approved O&M as a function of the project, but the statement should be qualified to avoid any implication that Congress believes past and present O&M practices per se are environmentally acceptable. It would be appropriate to present a figure here on the total expenditure for O&M to date.

Response: We do not feel that the statement as presented in the draft EIS implies that Congress believes that past and present O&M activities per se are environmentally acceptable. The statement indicates that Congress has appropriated funding for continued operation and maintenance of the 9-foot, believing that the expenditures were justified. Presentation of yearly expenditures for the period 1969 through 1973 is given on page 7 of the final EIS. A sum of the total expenditures on the O&M activities to date would be misleading, as the price levels have changed considerably since the beginning of the 9-foot channel project, and the cost of maintaining the channel in early years of the project are not directly comparable to the maintenance cost in current years.

Comment (26): Page 10, Paragraph 2- Define: weep holes.

Response: Weep holes are drain holes located to either provide drainage through or from the structure or to relieve excess water pressure which could threaten the integrity of the structure. This term has been changed to "drain holes" in the final EIS to make it more understandable to the average reader.

Comment (26): Page 11, Paragraph 2- Misspelling: tainer.

Response: Noted and corrected.

Comment (4,10): Page 13- The project is officially known as a "9-foot channel." However it is normally overdredged to 13 feet. Citation should

be made in the final EIS of authority to overdredge to this extent.

Response: The Chief of Engineers through ER 1130-2-307, dated 31 October 1968, subject: Dredging Policies and Practices, provides for overdepth dredging to avoid frequent redredging in order to maintain full project depths. The Division Engineer has the authority to authorize overdepth as deemed necessary. Citation of these specific authorities would not necessarily assist the reader in understanding the project and are not believed to be of sufficient significance to include them in the final EIS.

Comment (4,6): In the discussion of the DREDGE THOMPSON, a clear distinction should be made between total costs and costs for use within the St. Paul District. This would allow for a discussion of the primary and/or secondary impacts that the operation and maintenance within the St. Paul District have on the Rock Island District.

Response: Additional information regarding operation costs and the breakdown between the Districts is provided in the final EIS on page 14.

Comment (25): Dredging and dredge spoil placement with its turbidity and siltation being unavoidable, are the most mischievous aspects of the operation of the channel. If the dredging could be diminished we would take a giant step toward environmental recovery of the river. But discussion and exhibits of dredge spoil placement are misleading. Exhibits 32 through 42, which purport to show present dredge cuts and spoil banks, were derived by reference to records after 1956, and are grossly incomplete. Exhibit 76 clearly shows that in the years prior to 1956 at least twice the volume of material was removed from the river as in the years subsequent to 1956.

Response: The locations of dredge cuts and spoil areas as shown on Exhibits 32 through 42 are clearly stated as representing the areas affected during the period 1956 through 1972 and do not purport to show the complete record of dredge cut locations and spoil areas since the beginning of the project. However, by use of the information presented in Exhibits 43 through 55, a more complete picture of the total dredging accomplished since the beginning of the project can be obtained. Through examination of the information presented on Exhibits 43 through 55, the differences in the dredging accomplished during the period prior to and after 1956 can be compared. It should be noted that in the majority of cases the dredging locations did not change significantly from the period prior to 1956 and the period after 1956, and thus the dredge cut and spoil area information presented on Exhibits 32 through 42 actually represent the majority of dredge cuts and spoil areas since the beginning of the 9-foot channel project. Although the volume in the period prior to 1956 was greater than after 1956, the areas affected by the dredging are generally indicated on

the exhibits, primarily because the subsequent dredging operations used most of the same disposal areas as were used in the early dredging.

Comment (10,18,25): Detailed description of maintenance dredging and spoil disposal - The discussion of the dredging operations (page 14, paragraph 1) states that overdepth dredging to 11 feet is often required, and a few lines later that "an additional 2-foot of overdepth dredging is normally accomplished . . . ." Such depths may be needed in special areas where tows start and stop frequently, but we question the need to overdredge in most reaches of the river. Certainly, the conditions under which such overdepth dredging is required, and to what depth, where, and when it will be applied to the proposed 9-foot channel, should be clearly stated. Also, the comparative volumes and impacts associated with overdredging should be identified. As now written, this section suggests a magnitude of dredging that is at considerable variance with the magnitude implicit in the title of the statement. The actual total dredging depths on the Minnesota River also should be stated.

Response: The average depth of material dredged by the DREDGE THOMPSON is 3 feet. For a 1-foot reduction in the amount of overdepth dredging an initial dredged material quantity reduction of 33 percent would occur. However, an increased frequency of dredging would be anticipated due to shoaling. Since dredging has been accomplished to 13 feet in the past, no experience record is available to project any reduction, or determine if a reduction would actually occur. The information regarding depths of dredging is not at considerable variance with the title of the EIS.

The final EIS has been revised to indicate that the Minnesota River channel is normally dredged to a depth of 12 feet when required.

Comment (4,18): Page 14, Paragraph One, Fifth Sentence - If the 9-foot channel is actually dredged to a depth of thirteen feet, would the 12-foot channel be dredged to sixteen feet?

Response: This would be dependent upon the criteria established for any proposed channel deepening. Since this EIS pertains to the 9-foot channel, a discussion of a proposed 12-foot channel is not considered necessary.

Comment (18): Page 15, Bottom Picture - It is interesting to note that the spoil site being created in front of the private residence is an uncontained spoil site, and that no attempt has been made to reduce turbidity created by the discharge. In such an instance, this spoil site could contribute to poor land use practices in the floodway of the Mississippi River.

Response: Comment noted.

Comment (26): Page 17, Paragraph 1- Define: spuds.

Response: Spuds are vertical steel columns used at the end or corners of a dredge which when dropped to the channel bottom hold the vessel in place and provide a point about which the dredge can pivot. No revisions have been made on this point in the final EIS, as their description in the text appears adequate.

Comment (26): Page 18, Paragraph 1- Explain: deferred salaries.

Response: Key personnel of the dredging plant are retained during the non-operating part of the year and are used for maintenance and repair of equipment. For cost accounting purposes, their salaries are charged against operation of the dredge during the next operating season. No revisions on this point have been made in the final EIS as the term is felt to be readily understandable by the average reader.

Comment (26): Page 18, Paragraph 2- Define: gantry.

Response: A gantry is a steel frame mounted on a crane through which the cables that support the crane boom travel or are attached. The word "crane" has been substituted for "gantry" in the final EIS to make the section more understandable to the reader.

Comment (10): Page 18- It would be desirable to present FY 1973 costs of operating the DREDGE THOMPSON within the study area (St. Paul District) in terms of annual cost as well as daily cost.

Response: Additional cost data has been provided on page 14 of the final EIS, which includes the 1973 calendar year costs for the DREDGE THOMPSON. Fiscal year costs would be difficult for the average reader to understand in the context of the seasonal manner in which the dredging is done.

Comment (10): Page 18- There is an apparent discrepancy when 17,000 cu. yd./day for DREDGE THOMPSON is multiplied by 210-day normal annual utilization period results in 3,570,000 cu.yd./year on page 20, the report states the dredge moves "approximately 3 million cu.yd./year." This is 19% over annual volume stated and should be explained or rectified.

Response: The utilization period includes the period from initial mobilization to the final demobilization including Saturdays and Sundays during the 5-day operation periods. The average of 17,000 cubic yards per day refers to operating days only. The referenced 210-day figure has been revised in the final EIS.

Comment (10): Page 19- The reason for the 1½ mile limit on the range of dump scow movement from dredge site to disposal site should be explained.

Response: The 1½ mile limit is strictly an economic restraint. The derrickbarge attendant plant is currently limited to 4 dump scows and 4 tenders. If the range is increased beyond the 1½ miles, the derrickbarge stands idle waiting for the return of the dump scows under average dredging conditions. This results in increased unit cost of production. We believe that the description as presented in the draft EIS appropriately describes the operation and no modifications have been made on this point in the final EIS.

Comment (18): Page 20, Paragraph One, Fourth Sentence - A total cost of 32.7 cents per cubic yard for dredge spoil disposal on the Mississippi River is extremely low when compared to dredge spoil costs for other projects. There are instances when the cost for dredge spoil disposal exceeds $5.00 per cubic yard for contained dredge spoil sites.

Response: Comment noted.

Comment (10): Page 20- Using all daily cost considerations given for the DREDGE THOMPSON, total cost per cu. yd. based on 3,000,000 cu/yd/yr, is 38¢ cu. yd. rather than either 28.6¢ or 32.7¢ given in the report. This seems to be an important discrepancy which deserves explanation.

Response: The 3,000,000 cubic yards per year is an average figure. The 28.6¢ and the 32.7¢ are actual costs for a specific year. Calendar year 1973 costs were 30.6¢ per cubic yard actual plant cost, and 34.7¢ per cubic yard including the cost of surveys, inspections, etc. Additional cost data has been furnished in the final EIS on page 16 .

Comment (10): Page 20- What is meant by "adequate depth" and for what use is it considered adequate on the St. Croix River above the 9-foot channel?

Response: "Adequate depth" on the St. Croix above the 9-foot channel refers to depths for canoes and light recreational craft. The text in the final EIS has been revised to reflect this comment.

Comment (26): Page 20, Paragraph 2- 3 million cubic yards of solids, or solid plus water?

Response: The references in the text concerning cubic yards refers to solids, unless otherwise noted.

Comment (26): Page 21, Paragraph 1- "Production" does not seem to be appropriate here.

Response: The text of the final EIS has been revised to clarify this matter on page 16.

Comment (10,26): Page 21- Why use 1972 costs for DERRICKBARGE HAUSER if they are not typical? What factors allowed for the lower-cost operation in 1972?

Response: The latest cost data available at the time of preparation of the draft EIS was for the 1972 navigation season. During that season exceptionally heavy dredging requirements were accomplished and very desirable operating conditions were experienced. Data for the 1973 dredging season has since been compiled which shows a cost of $1.96 per cubic yard. Additional cost information is provided in the final EIS relative to this subject on page 16.

Comment (6): The final statement should note the recent commitment made by the Corps of Engineers in a recent meeting of the Upper Mississippi River Basin Commission Task Force (UMRBC) on Dredge Spoil. This commitment is to provide 30 days notice to all task force members of all future dredging. Information provided is to include location of dredge cuts, associated values, and proposed dredging dates.

Response: The referenced commitment made to the UMRBC Task Force on Dredge Spoil has been revised in subsequent meetings with the Task Force. Provision of 30 days notice with the specific information regarding each dredge cut without significantly affecting scheduling and possibly navigation is extremely difficult. Since the information is provided to all concerned parties as soon as available, inclusion in the final EIS of the referenced commitment and subsequent modifications are not believed to be appropriate.

Comment (6): It is customary for the Corps of Engineers to inform interested agencies of proposed dredging sites (page 22). However, only a short period, usually less than 1 week, exists between "notification" and "implementation." As such, onsite evaluation and coordination is difficult and, when only 3 days or less are allowed, adequate site evaluation becomes impossible.

Response: It is current Corps of Engineers' policy to provide maximum lead time prior to initiation of dredging. This includes an annual spring estimate based on latest channel condition surveys and past experience, noting individual site problems as general channel condition surveys occur, specific information as detail surveys are accomplished

and notification as dredging schedules are determined. However, if rapid channel condition changes occur, a predetermined time frame cannot be guaranteed.

Comment (18): Page 22, Second Paragraph, First Sentence - We know of many instances when these dredge requirements have not been delivered in a timely manner. At times, we have not received the information on where the dredging would be undertaken until after the DREDGE THOMPSON has already started work. In other instances, information was received only a few days prior to when the dredging was scheduled.

Response: We are currently providing data as the information becomes available. A non-line-of-site integrated electronic hydrographic survey system is being requested in our FY 1976 budget to allow improved channel condition survey capability. This would allow more frequent surveys with additional scope. However, this will not eliminate short notices where rapid changes occur.

Comment (18): Page 23, Second Sentence - We know of instances in the State of Wisconsin where the 1969 Dredge Spoil Survey was used as a justification for spoiling in certain areas. This survey report was rescinded in part because of such misuses and for instances of non-compliance with the recommendations contained in it.

Response: Refer to text change in final EIS on page 17. Full compliance with all of the recommendations of the 1969 Dredge Spoil Survey was and is not practical with the current capabilities of the dredge. Efforts were made to comply with these recommendations to the maximum extent practical.

Comment (18): Page 23, Fourth Sentence - The dredge spoil conference which is referred to in this sentence is set up early in the dredging season before any detailed information on dredge sites and dredge spoil disposal areas is known. This meeting has often been extremely frustrating since no solutions have been proposed. Since the project is undertaken with the existing plant, the only alternative which is available is what type of habitat will be traded off next. The Corps is aware that coordination at these meetings is difficult due to the restrictions placed upon dredge spoil disposal locations; however, no solutions have been proposed to date.

Response: Coordinating agencies have always requested the meeting be held at an early date and projections have been limited at best. At no time can one provide a complete package of the dredging requirements for the balance of the navigation season until later in the year. The Corps is studying alternative disposal methods on an independent $30,000,000 study at the Vicksberg Waterways Experimental Station. The answers to these problems are complex.

Comment (6): The statement (page 23) that dredge spoil sites were selected in conformance with the 1969 Dredge Spoil Survey is misleading and not entirely correct. Only those sites that were convenient and easily reached were utilized. In actual practice, if recommended sites did not exist within easy reach, the spoil was placed wherever convenient. Many of the recommended spoil sites are now beyond capacity and spoil is spreading beyond the defined site. We understand that it was for these and many other reasons that the 1969 Dredge Spoil Survey report was rescinded by the Upper Mississippi River Conservation Committee (UMRCC).

Response: The referenced statement has been revised in the final EIS on page 17. Also refer to the previous Comment/Response. The reasons stated by Mr. Lopinot, Chairman, UMRCC, for rescinding the UMRCC 1969 Dredge Spoil Survey report are:

"Since the 1969 survey report was prepared, several social and physical changes have occurred which tend to both nullify many of our recommendations and complicate the dredge spoil issue:

1. The 1964-base maps used in the 1969 report are outdated and do not reflect current physiographic features.

2. Two major floods have occurred since field work for the 1969 report was compiled and the river, being dynamic, has modified many floodplain features. Many specific 1969 report recommendations, therefore, no longer reflect least destructive alternatives.

3. Information as to spoil material volume at specific sites were not known at the time of the 1969 dredge spoil survey. Considerable dredge spoiling has taken place since the 1969 report, so we now find numerous suggested spoil areas already over-burdened with spoil.

4. Considerable dike construction has occurred in the middle river since the late 1960's. The dikework has modified the middle river considerably in recent years, often leaving specific recommendations for this river reach outdated or non-representative.

5. Legislation in several states now preempts spoil material placement within floodplains or designated floodways.

6. Recent State and Federal mandates dictate that the agencies concerned must view the environment from a broad spectrum. Constraints used for the 1969 report can no longer be accepted. A comprehensive viewpoint must be applied in the future.

7. Recent events have unfortunately indicated that this informal 1969 report, prepared as an aid to operations under the above-stated constraints, has been misinterpreted and misused by the Corps of Engineers to the disadvantage of cooperators. Of general concern are the specific suggestions as indicated on the report maps, for the placement of materials.

For these reasons, we now find it necessary to rescind the 1969 report and especially the specific site suggestions for spoil placement as designated on the charts. Written report recommendations can serve as good guidelines for interim spoil placement as long as it is understood by all that these recommendations likely represent only "least destructive alternatives" given present dredge plant capacity constraints."

Comment (10): Pages 23-24- The tone of the discussion on Corps coordination of spoil disposal plans with "conservation and environmental interests" implies by omission that there is either no coordination with "navigation interests," or that the Corps is the public representative of "navigation interests." Our Commission has always assumed that the Corps is a public agency responsible for the "public interest" in its broadest sense and that it should not approach coordination responsibilities as they they are an adversary proceeding. Further, since the annual dredge spoil conference to coordinate dredge disposal with concerned conservation and environmental agencies is mentioned, it would be desirable to describe the purpose of the annual meeting between the Corps and "navigation interests" on O&M matters.

Also, the representation of "fish and wildlife, recreation, State and Federal interests" as the only parties having "conflicting desires" among themselves is unfair in that it omits the "navigation interests," thus inferring that the latter are not involved in the "conflict of interest" situation.

The citation of increasing difficulty of coordination caused by requests for "disposal in a manner beyond plant capabilities" infers that expansion of plant capabilities is not feasible. This is true only if Congress would not authorize and fund such expansion.

Response: The Corps holds coordination meetings with various concerned interests as necessary and does not approach coordination responsibilities as though they are adversary proceedings. The discussion in the draft EIS referenced in this comment is concerned with the disposal of dredged material and as such only those interests most actively interested and involved normally attend the meetings. The navigation interests do not normally attend these dredge disposal meetings as their main concerns lie with navigation being maintained and not with the exact placement of the dredge spoil.

Coordination is maintained with the navigation interests and the final EIS so notes. The expansion of plant capabilities and associated aspects are discussed in the Alternatives section of the EIS.

Comment (6): It should be noted that the annual dredge spoil conferences were initiated in 1971 at the request of concerned agencies. Similar conferences are held each year in the Rock Island and St. Louis Districts to try to resolve difficult problems on specific spoil disposal areas. Since the dredging in the St. Paul District begins soon after the spring flood, little information is available on channel conditions. This causes the difficulties in coordination as to spoil area selection and should not be related to the "conflicting desires among fish and wildlife, recreation, State and Federal interests" (page 24).

Response: This information has been incorporated into the final EIS on page 17.

Comment (10): Page 24- A serious information gap hampering proper evaluation of the effects of all dredge spoil disposal on the resources of the study area is noted in trying to analyze the cut and disposal site maps in Exhibits 32 through 42. These exhibits are incomplete since they show only those cut and spoil placement areas affected from 1956 through 1972, or for only 17 years of the 36-year history of the project. This presentation is especially deficient when one considers that, according to the figures provided in Exhibit 56, 64.4% of the total O&M dredging of the project (by volume) occurred prior to 1956. If there are records available on such sites prior to 1956, they should definitely be provided in the final EIS. If there are no such records, the Corps should explain why.

Response: Refer to previous Comment/Response by (25) on page 394. All available historical information in Corps files with regard to dredge cut and disposal area positions is presented in Exhibits 32 through 42. Records of specific dredge cut and spoil areas prior to 1956 are not available from Corps' files. The volumes and locations of each dredge cut for the entire operation and maintenance of the project are shown in Exhibits 43 through 55.

Comment (18): Page 24, Third Paragraph, First Sentence - We would assume that the dredge spoil disposal sites which are shown in red on Exhibits 31 through 42 are diagrammatic since we have noted discrepancies in the location of the sites, particularly in the region of Indian Slough at the mouth of the Chippewa River.

Response: The dredge disposal sites shown in red on the referenced exhibits are accurate with regard to location, but are not considered precise with regard to specific extent of disposal areas. These disposal site delineations are based on data gathered at the time of dredging and are best estimates made by the dredge personnel as to the location and extent of the disposal area. There are additional areas of existing dredge spoil which are not shown on these exhibits (refer to previous comments).

Comment (18): Page 25, Second Paragraph, First Sentence - The spoil site indicated near Crosby Slough is rather interesting in that it shows considerable secondary movement of dredge spoil downstream from the disposal area.

Response: Comment noted.

Comment (18): We also note that there were three spoil sites which were placed in the open water at approximately river mile 790.7. A field investigation during the summer of 1973 revealed that only a small portion of one of these open water spoil sites remained. It is obvious that the other two and a good portion of the remaining spoil site had been eroded away.

Response: We have no records in our office or knowledge of open water disposal at River Mile 790.7.

Comment (26): Page 27, Paragraph 3- Misspelling: water furface

Response: Noted and corrected.

Comment (18): Page 31, Last Sentence - We assume that this sentence should read "the gate openings have been computed so the maximum allowable discharge will not be exceeded----".

Response: This sentence has been revised in the final EIS to include "maximum allowable velocity . . ." on page 22.

Comment (10): Page 35- The final EIS should clarify the inferred relationship of the installation of 9-foot channel works to the summer stagnation and fish kill effects cited.

Response: This subject has been adequately discussed on pages 35, 300 and 436 of the draft EIS.

Comment (4,6): Page 35- The statement should address the need for water quality improvement below the Twin Cities at lock and dams 2 and 3.

Response: This topic is covered in Section II, Environmental Setting of the final EIS.

Comment (10): Pages 35-36- It would be helpful to show in a map exhibit the location of the dam alterations made to improve water quality by restoration of backwater flows, and of the channels and backwater areas which benefited from these modifications.

Response: We concur that a map exhibit would be helpful for a more detailed evaluation and understanding of these referenced improvements; however, we feel that these improvements are adequately referenced in the text. Additional information is available in the offices of the St. Paul District Corps of Engineers and the Bureau of Sport Fisheries and Wildlife.

Comment (26): Page 42, Paragraph 3 and Page 43, Paragraph 2 - "Modification" would be a less biased term than "improvement" and would be understandable to ordinary readers.

Response: These projects were undertaken as improvements to the human quality of life. We do not feel that modifications are necessarily an adequate substitute and no change has been made.

Comment (18): Page 42, Fourth Sentence - Although the volume of material dredged for the maintenance of harbors is small compared to that dredged for the navigation channel, any spoil deposition in critical fish and wildlife habitat could have a significant impact.

Response: The relatively small quantities of harbor maintenance dredging referred to in the above comment is in regard to privately-owned harbors. This type of dredging by private interests must have permits from the Corps of Engineers and the respective State, as well as any necessary local permits. If significant environmental impacts are expected as a result of such dredging activity, an environmental impact statement on the dredging can be required by either the Corps or the respective State. Any significant environmental impacts caused by this dredging should thusly be identified.

Comment (10): Page 42- Why are details of maintenance dredging of privately-owned or non-Federal harbors "not readily available" when the Corps was presumably the agency responsible for issuing permits for such activities?

Response: Although the information concerning maintenance dredging of non-Federal harbors can be obtained by reviewing the permit applications in the files of this office, the quantities of harbor maintenance dredging are insignificant when compared to the maintenance dredging of the main channel and a considerable amount of time would be necessary to extract the information.

Comment (10): The statement that construction of the commercial and small boat harbors listed here "is a direct result of construction of the 9-foot channel project" is speculative. Many of these harbors, especially recreational harbors, might have been built on a 6-foot channel.

Response: The referenced statement has been revised in the final EIS on page 29 .

Comment (13): Page 43, First Paragraph, First Sentence - The "swale" referred to is an extension of the bottom lands between Cochrane and Fountain City. These bottoms are included within the state-owned Whitman Dam Wildlife Area. The seepage through the ditch has the same effect as a series of springs, and open water exists all winter. It is a wintering area for a considerable flock of mallards and black ducks.

Response: Comment noted.

Comment (6): The Upper Iowa River, Iowa section should be expanded to discuss further the problem of deposited material that takes place as the result of construction activity. We believe that the Upper Iowa River outlet project not only caused heavy siltation of downstream marsh areas at the time of construction but apparently will increase siltation below the mouth. Minnesota Slough similarly has been adversely affected, and in recent years, other chutes and sloughs alike have silted in at an alarming rate. Projects such as the Zumbro River Channelization proposal, Minnesota, definitely warrants discussion in the statement.

Response: The historical tabular summary of dredging records in pool 9, Exhibit 24, shows that the closest, most frequently dredged area below the confluence of the Upper Iowa and the Mississippi River at mile 671 is the stretch of river between mile 663.8 and 665.9. The frequency and quantity of dredging in this reach has increased substantially after 1952. It is not known how much, if any of this increase in dredging requirements is attributed to construction and/or possible increased siltation loads carried by the Upper Iowa River. The dredging requirements at this location, although no less important than any other location on the river, are only one small part of the total dredging requirements. Quantitative estimates of the percentage of sediment contributed by specific sources to each dredging site is not known. The projects discussed in this section are presented because of their relationship to operation and maintenance of the 9-foot channel. The full effects of their relationship to the operation and maintenance of the 9-foot channel however is not discussed. A discussion of such relationships as well as any specific impacts of such projects would be dependent on the availability of an environmental impact statement on each of the subject projects.

The Zumbro River project is not anticipated to have any effect on operation and maintenance of the 9-foot channel and therefore is not discussed.

Comment (26): Page 46- heading: The real name of the refuge is the "Wild Life and Fish Refuge".

Response: Concur. The heading on page 46 of the draft EIS reads "The Upper Mississippi River Wildlife and Fish Refuge". This is the correct name of the refuge, therefore no correction in the heading is necessary.

Comment (26): Page 48, Paragraph 1- "Improvement" should probably read "maintenance."

Response: Refer to comment made by (10) and response on following page.

Comment (18): Page 47, Items A and B - We request that a breakdown of spoil disposal sites by ownership of land be provided in this section. As in the past, the disposal of any dredge spoil materials on islands or land owned by the Department of Natural Resources will not be allowed.

Response: A breakdown of spoil disosal sites by ownership of land is not readily available, however dredge spoil is placed in open water, on Federal lands, or on non-Federal lands when proper permission to place the spoil is obtained.

Comment (4,6,10,18,28): Page 47- The statement that the Upper Mississippi River Wildlife and Fish Refuge "became a reality to a large degree as a result of the 9-foot channel project" is somewhat misleading. It would be more accurate to say that the character of the Refuge was significantly altered by the advent of the 9-foot channel project, since the Refuge had already been in existence at least 10 years before the 9-foot channel project was completed. It was only after the initiation of the 9-foot channel project (July 3, 1930) that land was acquired for the project. Following this, lands held by the Corps of Engineers were added to the refuge by cooperative agreement.

Although approximately 43,000 acres of project-acquired land are now under cooperative management agreement with the U.S. Fish and Wildlife Service, the management rights on these lands (CE) are not comparable

to such rights on previously existing refuge lands since they are clouded by ownership questions. This difference should be examined in the statement, and the acres under refuge management before and after the 9-foot channel should be made known.

Response: There is little doubt that the 9-foot channel project significantly altered the Upper Mississippi River Wildlife and Fish Refuge, however we believe that the statement in the EIS is not misleading. By 1930 the entire Upper Mississippi River Wildlife and Fish Refuge encompassed about 87,000 acres of floodplain land. The Bureau of Sport Fisheries and Wildlife gave the Corps of Engineers flowage rights on refuge lands in return for wildlife management rights on land owned by the Corps. By this means the refuge was increased to about 195,000 acres. These figures are for the entire refuge and include areas outside the St. Paul District to Rock Island, Illinois. The 9-foot project, by dedicating almost 100% of the lands in the river bottoms to public ownership and control, brought to fruition the preservation of the bottom lands as a haven for wildlife and fishes and made the land available for public use. In 1930 the 87,000 acres of land purchased for the refuge was in a scattered pattern and as such, little in the way of efficient management could be initiated. Without the 9-foot channel project it is doubtful if the Upper Mississippi River Wildlife and Fish Refuge would be the great conservation area it is today.

Comment (10): Pages 47-48 - To say that "fish and wildlife interests" allege that Corps O&M activities are adversely affecting only the continued improvement of the refuge" is incomplete; the statement fails to reflect their widespread concern that serious degradation of the refuge is also resulting from such activities.

Response: It was not the intent of the draft EIS to make the above implication, therefore the last sentence on page 33 of the final EIS has been changed to read ". . . maintenance and operation activities, primarily dredge spoil disposal, are having an adverse impact on fish and wildlife habitat within the refuge."

Comment (12): The EIS states that the U.S. Army Corps of Engineers' maintenance of the 9-foot channel includes effort to improve the river for fisheries, wildlife, and recreational purposes within the authority and funding available. A specific breakdown of such funding is not given. While the project has possibly lead to increased fish habitat and productivity, there are indications that these effects may be temporary and have proven to be highly detrimental to the overall ecological balance upon which the fish, the wildlife, the vegetation, and indeed, man himself depends.

Response: We are not aware of any documented evidence indicating that the temporary effects of the 9-foot channel have proven to be highly detrimental to the overall ecological balance upon which fish, wildlife, vegetation and man depend. If your agency has such evidence we would appreciate being made aware of it. We feel that the relationship between short-term uses of man's environment versus the maintenance and enhancement of long-term productivity is adequately discussed in Section 7 of the final EIS.

Comment (10): Page 48- There should be a discussion of the Lower St. Croix Wild and Scenic Riverway project in this section.

Response: The Lower St. Croix Wild and Scenic Riverway Project is covered in the final EIS in Section 2, Environmental Setting, Projects and Proposals of Other Agencies.

Comment (18): Page 48- Since this section is devoted to the interrelationship and compatibility of operation and maintenance activities with other projects, we feel that some consideration should be given to the proposed 12-foot channel project, the proposed year-round navigation project, and the City of La Crosse flood control proposal.

Response: The 12-foot channel project and year-round navigation project are not proposed for, nor being actively studied within the St. Paul District, therefore no discussion of them is felt justified for this portion of the operation and maintenance of the 9-foot channel project. Information is included on the proposed La Crosse flood control project in the final EIS on page 32.

Comment (18): Page 48, Last Sentence - We would suggest that this sentence be changed to read, "However, more recently, fish and wildlife interests have stated that maintenance and operation activities, primarily dredge spoil disposal, are having an adverse effect on fish and wildlife habitat."

Response: The above change has been made on page 34 of the final EIS.

ENVIRONMENTAL SETTING

Comment (10): The final EIS should be written so as to present a much more balanced appraisal and comparative analysis of all significant environmental, social and economic values associated with the Upper Mississippi River. The draft EIS consistently overstated commercial navigation use and present O&M beneficial factors. It either understated or omitted entirely information of comparable significance relating to recreation, fish and wildlife uses and values. These values are real; they must be quantified as monetary benefits where they are enhanced by the project, or as costs where they are reduced by the project. Where only fragmentary data exists, such as on fishermen observed from locks and dams at 3:00 p.m. or numbers of pleasure boats locked through, the final EIS should estimate the ratio of observed users to total use of pool segments.

Response: Information relative to recreation, fish and wildlife use and value has been included in the EIS whenever and wherever possible. Quantification of subjective values is obviously difficult, if not impossible, with what is presently known about recreational values or demands. Should such values become more definitive and/or objective in the near future they could be included in any updating or revision of the EIS.

Comment (11): The organization of Sections 2 and 3 should be improved. For example, Section 3 is titled Environmental Impact; but the last 25 pages of Section 2 also deal with environmental impacts. We feel that the last 25 pages of Section 2 should be included in Section 3 for better organization. This would also eliminate some of the repetition in the draft EIS.

Response: That material contained within the Environmental Setting section deals particularly with impacts of the lock and dam project. Operation and maintenance impacts are those subjects for which the statement is directed, and are correctly included in the Environmental Impact section.

Comment (1): An adequate description of the dredged spoil is required for major areas of dredging as soon as practicable. A sediment analysis and characterization would insure compliance with our acceptability criteria for spoil disposal, facilitate prudent selection of spoil sites and also serve as a basis for determining the compatibility and usefulness of spoil.

Response: To supplement the current information available on the nature of the dredged material, a cooperative interagency sampling program is in the process of being initiated to determine a more accurate description of the material being dredged. The results of such information would be used to determine more appropriately the disposal methods utilized with the dredging operations.

Comment (18): Page 49, First Paragraph, Second Sentence - The treatment of the 9-foot navigation project is of extreme concern to us since it has allowed for an over-emphasis of beneficial impacts and an under-emphasis of the adverse impacts.

Response: The EIS addresses the impacts of the project as an aid to understanding the role that the project plays in the current environmental setting. There has been no attempt to over-emphasize benefits nor to under-emphasize adverse impacts. The current guidelines for preparation of an EIS have been followed in the preparation of this EIS.

Comment (26): On page 49, paragraph 2, Lake Itasca is misspelled.

Response: Change has been made on page 35 of the final EIS.

Comment (10): On page 50 the citation of Mississippi-Minnesota Rivers junction is out of sequence.

Response: Concur. Sequence has been changed accordingly on page 35 of the final EIS.

Comment (18): Page 50, Third Paragraph, Third Sentence - It should be clarified that all waters from the Black River enter pool 7 above Lake Onalaska. The old mouth of the Black River has been inundated by pool 7.

Response: The indicated sentence has been modified on page 35 of the final EIS as follows: "Waters of the Black River flow into Lake Onalaska. A portion of Lake Onalaska passes through the Onalaska Dam and Spillway and enters the Mississippi River downstream near LaCrosse, Wisconsin."

Comment (18): Page 51, Second Paragraph - We suggest that the average annual discharge of the Wisconsin River be included in this section. It would also be appropriate that major rivers such as the Chippewa, Black, Trempealeau, and Wisconsin be given more attention in the Environmental Impact Statement.

Response: Subject information has been added in appropriate sections of the final EIS.

Comment (18): Page 52, First Paragraph, Last Sentence - We suggest that this sentence be changed to read, "The drainage is so good that few natural lakes exist in this section except on the Mississippi River floodplain."

Response: Concur. The sentence has been changed accordingly on page 36 of the final EIS.

Comment (3): Pages 52, 53, and 54 - Driftless Section is more conventionally known as Driftless Area.

Response: Concur. Correction has been made.

Comment (11): Page 55, Bottom paragraph, last complete sentence - River Warren is not the modern Mississippi but is the Minnesota River.

Response: Concur. Subject sentence has been changed to read, "The post-glacial Mississippi River discharge, combined with flow from glacial River

Warren, had a capacity great enough to transport all the Chippewa River sediment" on page 38 of the final EIS.

Comment (6): In the discussion of groundwater (starting on page 57), some statements should be corrected or expanded to avoid confusion. The dolomite strata under discussion are fractured and jointed and may be cavernous in places, but we do not believe that they are cavernous generally. The use of the term "large springs" (last line) may be misleading and should be defined in terms of discharge per unit of time.

Response: Subject information and appropriate modification of the text is presented on page 39 of the final EIS.

Comment (11): Page 58 - This section would be simplified if a stratigraphic section were presented.

Response: A stratigraphic section is included on page 40 of the final EIS.

Comment (6): With reference to page 58, paragraph 2, there are many communities around the Twin Cities utilizing deep wells; thus, we suggest that 13 communities mentioned by fully identified. In sentence three of the same paragraph, 200 mgd is estimated to be one-fourth of the sustained yield. We belive that 200 mgd may be more nearly 50 percent of the sustained yield under natural conditions, but in either case, the area under discussion needs to be more clearly defined.

Response: Subject discussion has been modified on page 41 of the final EIS.

Comment (3): On pages 58 and 59, Hinckley is misspelled and on page 59, Precambrian is misspelled.

Response: Noted and corrected in the final EIS.

Comment (6): "This highly productive aquifer" (page 60, paragraph 2) refers to the water table of the floodplain--a geographic feature which is not an aquifer. The alluvium of valley fill underlying the floodplain is the aquifer. In the same paragraph, what is the basis of the third sentence? We doubt that "Groundwater from a maximum depth of approximately 100 feet is largely natural filtered river water," as the river valley is normally the groundwater discharge area with groundwater flowing to the river.

Response: Subject information and appropriate modification of the text is presented on page 41 of the final EIS.

Comment (3): Exhibit 61 - Lake sills and clays should read silts. The diagram is not well explained.

Response: Correction has been made on subject exhibit in the final EIS.

Comment (26): On page 65, paragraph 2, Starring Lake should be Staring Lake.

Response: Correction has been made in the final EIS.

Comment (26): Page 67, Paragraph 2 - "regosols" should be defined.

Response: A definition of regosols, as derived from Millan, et. al. 1965, Fundamentals of Soil Science (John Wiley and Sons, 491 pp.), is as follows: "An azonal group of soils consisting of deep, soft mineral deposits (unconsolidated rock) in which few if any clearly expressed soil characteristics have developed; largely confined to recent sand dunes, loess, and glacial drift of steeply sloping lands."

Comment (26): On page 74, paragraph 2, the segment beginning with "Sand and gravel..." and ending with "costly to maintain.", appear to be irrelevant here.

Response: We disagree.

Comment (6): In the discussion of surface water (page 71 and Exhibit 62), the data are compiled only through the year 1965. We note the second highest flood of record occurred at St. Paul on April 15, 1969, with 156,000 cfs and a stage of 24.52 feet. The data should be updated, discussed and compared with other floods. The 1969 flood was the third highest flood of record at the Minnesota River at Mankato, Minnesota.

Response: Subject updating and modificaton of discussion has been included on page 47 of the final EIS and in the appropriate exhibit.

Comment (18): Page 74, First Paragraph - In reviewing this draft Environmental Impact Statement, it is obvious that there is much to be learned about the movement of bedload and subsequent redeposition of sediments and also the long-term changes induced by sedimentation. We strongly recommend that continued investigation of sedimentation be undertaken since it is not clear which are the consequence of the original channel establishment and which are being induced by continued dredging.

Response: We agree that more information would be desirable to determine more accurately the relationship that exists between operation and maintenance activities and sedimentation phenomena in the river. Some sediment data on inflowing tributary streams is beginning to be collected. Other data collections and studies with respect to sediment movement are proposed in the Statement of Findings accompanying the final EIS.

Comment (18): Page 74, Last Sentence - The cost of $1,000,000 for dredging in the St. Paul District does not agree with the figures given on page 20.

Response: The figure stated on page 74 of the draft EIS was used as an approximate number. The addition of the DREDGE THOMPSON costs, plus

the DERRICKBARGE HAUSER costs, and costs incurred for other dredging, including contract dredging, would provide the total cost of dredging in the St. Paul District for any given year. The costs presented on page 20 of the draft EIS were for a specific year and are in general agreement with the statement, contrary to your observations. Additional information regarding operation costs of the DREDGE THOMPSON have been provided in the final EIS on page 14.

Comment (11): Page 74-75 - The comments relating to sedimentation may not be entirely correct; e.g., "Similar adverse impacts also result from naturally occuring sediment deposition unrelated to dredging operations." Please explain these similar impacts. Natural sedimentation process has enhanced the fertility of floodplains. Spoil placement due to dredging decreases natural floodplain fertility. The natural phenomena of sediment deposition is much more orderly than sediment deposition done via dredging. Dredging allows for no natural sorting and deposition. Thus, sediment placement due to dredging in the floodplain poses a greater environmental impact than the natural process of sediment deposition.

Response: Sediment deposition from natural processes, particularly during floods, causes adverse impacts similar in type to those caused by dredging operations, including turbidity, cutting of backwater openings, burial of aquatic and terrestrial vegetation, and so on. However, the degree and extent of these adverse impacts may differ markedly. For example, turbidity effects from dredging operations are very limited in area and duration compared to those resulting from floods. Conversely, placement of dredge spoil at any particular site results in burial of aquatic or terrestrial vegetation to a degree not likely to be duplicated under natural conditions except in infrequent occurrences. Generally speaking, dredging operations affect a much smaller area than natural processes, but tend to concentrate adverse impacts so as to cause more severe localized effects.

Comment (6): While it is true, (page 74) that in certain instances agricultural land in small areas can be damaged by floodwater-deposited sand and gravel, it should likewise be pointed out that floods often make river floodplains highly productive areas for many plant and animal communities. The slow moving water over most of the floodplain during floods causes the finer silt to drop out and it is this rich, organic material that nourishes the floodplain.

Response: Comment noted; however, the intent of the discussion in question is to point out sediment-related problems in the study area, rather than to debate the relative advantages and disadvantages of floods. If the latter were the case, the comment should have noted also that floodwaters may remove topsoil rather than enriching it and that plant and animal communities may suffer severe hardships and losses due to floods.

Comment (6): The discussion on sedimentation, starting on page 74, is confusing to the reader because "total load" and "bedload" are intermingled in the discussion and in presentation of the data.

Response: The total sediment load consists of the suspended load plus the bedload. Because the suspended load and bedload fractions of the total load differ markedly in relative importance with regard to maintenance of the 9-foot navigation channel, the sedimentation discussion must necessarily cover all three. Although a clear distinction between suspended load, bedload, and total load is maintained throughout the text, it behooves the reader to be cognizant of which one is under discussion in the section being perused.

Comment (17): Within the draft Environmental Impact Statement itself, there are several substantial ambiguities which lead to contradictions on important points. For instance, on page 75, it is stated that "Dredging is also costly in terms of possible adverse environmental, social, and ecological impacts..." On page 263, it is stated that "It is not always possible to clearly differentiate between the effects of the project and natural events occurring on the river nor is it always possible to decide whether a given impact is beneficial or adverse."

Response: It is not believed that subject sentences are contradictory.

Comment (18): Page 75, Second Sentence - We do not agree that natural sedimentation is similar to that from dredging operations since sediment deposition by natural forces is gradual, allowing for an adequate opportunity for vegetative adaptations.

Response: Sediment deposition from natural processes, particularly during floods, causes adverse impacts similar in type to those caused by dredging operations, including turbidity, cutting off backwater openings, burial of aquatic and terrestrial vegetation, and so on. However, the degree and extent of these adverse impacts may differ markedly. For example, turbidity effects from dredging operations are very limited in area and duration compared to those resulting from floods. Conversely, placement of dredge spoil at any particular site results in burial of aquatic or terrestrial vegetation to a degree not likely to be duplicated under natural conditions except in infrequent occurrences. Generally speaking, dredging operations affect a much smaller area than natural processes, but tend to concentrate adverse impacts so as to cause more severe localized effects.

Comment (10): Page 75 - Another adverse ecological impact is destruction, or inhibited hatching success, of fish eggs.

Response: It is believed that potential adverse impacts on fish productivity is implied in "ecological impacts from turbidity" as stated in the draft EIS.

Comment (4): With reference to page 75, nutrients carried downstream by flood waters play an important role in fish production. This fact is well illustrated by the Aswan Dam situation, where the loss of nutrients to the delta area caused an abrupt decline in sardine catches in the Mediterranean.

Response: Concur.

Comment (10): On page 76, it would be appropriate to acknowledge that downstream tributary watersheds in the study area have unusually high sediment yield rates due to a combination of erodable soil, agricultural uses and topography.

Response: We agree that the indicated information should be added to the final EIS. However, the information was added to page 61 rather than to page 60 of the final EIS. The sentence "This region has a relatively high sediment yield," was changed to read "This region has a relatively high sediment yield due to a combination of erodable soil, agricultural uses and topography."

Comment (11): Page 76 - Are the figures for sheet erosion and annual gully erosion applicable to this specific area? We would suggest further documentation since sheet erosion is usually the greatest sediment contributor.

Response: The erosion rates were taken from the Upper Mississippi River Comprehensive Basin Study with the intent of comparing the relative severity of sheet and channel erosion in extreme cases. The particular figures quoted may not be representative of erosion rates within the St. Paul District. Although gully erosion is capable of yielding extremely high sediment quantities in a given vicinity, sheet erosion contributes a greater volume of sediment when compared on a regional basis.

Comment (25): Page 77, Paragraph 3 - Reference needed--just one of many places.

Response: Comment noted. Particular reference requested is the Upper Mississippi River Comprehensive Basin Study.

Comment (3): Page 77 - If study areas are designated as Northern Lake States Forest and Forage Region, etc., the correct terminology is land resource region K, L, M, etc.

Response: Such suggested terminology might be meaningful to those with forestry expertise, but for the average reader the designations used would be more appropriate.

Comment (3): Page 77 - Sediment yields - Since the particular land use which increases erosion and sedimentation much beyond a geologic norm is cropland, it would be most instructive to state the percent of land or acres of cropland in the two land resource regions K and M.

Response: According to figures compiled in the Upper Mississippi River Comprehensive Basin Study, the St. Paul District portions of the "Northern Lake States Forest and Forage Region" (land resource region K) and the "Central Feed Grains and Livestock Region" (land resource region M) consist of about 20 and 65 percent cropland, respectively.

Comment (18): Exhibit 63 - The St. Croix River is labeled wrong on this exhibit.

Response: Concur. This has been revised in final EIS.

Comment (18): Pages 79 and 81 - It is indicated in paragraph two of page 79 and paragraph one of page 81 that the material being dredged for maintenance of the 9-foot channel consists mainly of bedload, and that the bedload is an average of ten percent (range of 0-40 percent) of the total sediment load of the Mississippi River. In paragraph one of page 82 it is indicated that the coarser bedload material is normally contained within the navigation channel except during periods of heavy flooding when backwater areas receive faster flows than normal resulting in a deeper penetration and more deposition of sediments. Therefore, it could be concluded that reducing bank erosion, which is a primary source of bedload, would not only benefit maintenance of the navigation channel but would also decrease sedimentation of backwater areas during periods of heavy flooding.

Response: Concur.

Comment (10): Page 79 - The statement accurately indicates the major source of sediment is sheet erosion; the sediment carrying capacity of the river has been reduced by 9-foot channel locks and dams; this increased deposition of finer sediments, which, prior to the 9-foot project, may have remained in suspension are likely to precipitate out in the floodplain and quiet backwater areas. Acknowledgement of the process in the context of the fact that sheet erosion is the primary source of sediment in the river system points up the need for a much fuller final EIS evaluation of erosion control measures within tributary watersheds than has been made in this draft, even though it might not have that much effect on dredging of the navigation channel.

Response: As discussed in the Foreword, attention in this EIS is focused on the effects of and alternatives to present methods of operating and maintaining the 9-foot navigation system. Some of the measures considered, including watershed land treatment measures aimed at curtailing sheet erosion, may alter the impacts associated with the presence of the navigation system but would likely have little effect on operation and maintenance aspects of the 9-foot channel. They would thus fall outside the purview of this report. Therefore, the coverage of sheet erosion control measures in the draft statement is considered adequate.

Comment (3): Page 79 - "The bedload carried by streams in the UMRB varies between 0 and 40 percent of the total sediment transported, generally being about 10 percent." What was the source of this data?

Response: The information was for the most part derived as a result of original analysis related to the preparation of the Upper Mississippi River Comprehensive Basin Study.

Comment (10): Page 80 - The "intended canalization effect" implies an objective of creating a canal for navigation segregated from the rest of the natural river environment. Such a policy would systematically severely damage, if not eliminate, thousands of acres of valuable riverine environment by closing off extensive off-channel areas (as has already happened in the Lower Missouri River). This effect, attributed in the statement to wing and closing dams, is being compounded by the present O&M practice of linear placement of dredge spoil materials along the navigation channel and between wing dams in many areas. Continuation of such a policy would be contrary to the intent of Congress under NEPA, demonstrating the need to modify O&M procedures.

Response: The choice of words was perhaps subject to misinterpretation and is changed in the final statement on page 62. The phrase "intended canalization effect" was not meant to imply, as the comment suggests, the "objective of creating a canal for navigation segregated from the rest of the natural river environment." The phrase was intended to mean, "to make navigable or improve the navigation of ..., to direct into certain channels." Prior to construction of the present system of the locks and dams, the river was made navigable for 6-foot draft vessels by constructing wing dams and closing dams tc construct flows in the main channel during periods of low discharge to aid in maintaining channel depths sufficient for navigation. Deposition of sediment between and behind the wing dams and closing dams by natural means and dredge spoil disposal has contributed to the effectiveness of these structures.

Comment (18): Page 80, Paragraph One, Third and Fourth Sentences - The "intended canalization effect" and increased "hydraulic efficiency" has had a harmful effect on fish and wildlife habitat. In order to provide more water in the main channel, it is necessary to reduce water in the backwater sloughs and channels. By doing this, sedimentation and eutrophication of the backwater areas is increased. Continued placement of dredge spoil in order to enhance the hydraulic efficiency of the channel seems to disregard the statement by the United States Water Resources Council that "It should be recognized that floodplains have unique and significant public values, including wildlife habitat of recreational, aesthetic and scientific value, open space, and ground water recharge. The value of the floodplain as an environmental resource and the public benefits derived from it should be considered."

Response: The comment makes the unfounded assertion that dredge spoil placement sites are selected on the basis of improving the hydraulic efficiency of the main channel. If this was true, dredge spoil would be placed to deliberately block off backwater openings and chutes off the main channel. This is obviously not the case. In actuality, present practices are to place the spoil in the least harmful site possible within the limits imposed by plant capabilities.

Comment (18): Page 83, Second Sentence - Our analysis of this sentence indicates that Exhibits 65 and 66 are less than estimates. It seems rather redundant to quantify data and then to consider those data as approximations.

Response: The trap efficiency procedure used in developing Exhibit 66 is recognized as having limitations when adapted for use with the navigation pools. Similarly, the data input for the procedure is limited in accuracy by the relative lack of sedimentation data in the study area. Consequently, one must accept the results as being approximations. Still, this procedure represents the best available method of analyzing the sediment balance of the navigation pools.

Comment (6): A serious question arises on the validity of calculating sedimentation rates when using Exhibit 65. The statement indicates that the results should be considered approximate. Yet, these approximations are used to prepare Exhibit 66 and are used to calculate in a most definite manner the percent of the bedload that is dredged. Moreover, Exhibit 65 is based on the operation of large, deep reservoirs that have little similarity to the navigation pools. If the navigation pools did fall within the range of the curve on Exhibit 65, they would be at the lower left corner where the accuracy is highly questionable. This is pointed out in Note 3 on Exhibit 66, but such inaccuracy holds true for all of the pools, not just pools 1 and 5A. Since much of the statement is based on the exhibits, more reliable data should be used and a better explanation of the use of the data is required.

Response: Sediment transport data for the study area is very limited. The trap efficiency procedure represents the best available method of estimating the sediment balance of the navigation pools. The limitations and possible inaccuracies of this method are recognized and pointed out to the reader; and adjustments were made where more recent and reliable data was available. Any future revisions of the EIS will incorporate newer, more applicable methods which may have been developed and whatever additional sedimentation data that may have been assembled in the interim.

Comment (18): Page 83, Item a - It is concluded that since more material is being dredged than is theoretically being deposited, additional sediments must be entering from bank erosion on the Mississippi River itself, from construction along the river banks, or from erosion of spoil banks. Thus, some of the same sediments may be dredged and deposited two or more times. We know of several instances where dredge spoil has been redeposited in the navigation channel. The current practice of depositing dredge spoil along the channel side of existing spoil sites in areas of fast flows and erosive velocities certainly contributes to the secondary movement of dredge spoil. The lack of containment and protection of spoil sites in the form of riprap and vegetation would obviously lead to erosion and redeposition of previously dredged sediments.

Response: Concur. For various reasons, such as plant capability limitations or concern for possible spoil migration into backwater areas, spoil may be placed on the channel side of existing disposal sites where there is a greater potential for secondary movement. Alternative solutions are considered in the EIS, including confined disposal and shore protection of disposal areas.

Comment (3): Exhibit 65 - This exhibit was first published by the Soil Conservation Service many years ago (1956 or before). Credit should be given SCS.

Response: Concur. Appropriate reference has been included in subject exhibit.

Comment (10): Page 84 - (Item b.) As the backwater areas become more and more isolated from the main river, the "detention time" increases, allowing more time for finer sediments to deposit. Thus, even the very fine sediments passing through Lake Pepin are likely to deposit in the more isolated downstream backwater areas in the future. Based on calculations using the figures given in Exhibit 66 for pools 2, 3 and 4 above the outlet of Lake Pepin, there appears to be an average annual outflow from Lake Pepin of over 350,000 tons (11%) of the fine sediments, which would have a significant impact on downstream areas. The draft said this "wash load...should cause little or no problems."

Response: The figure 350,000 tons is incorrect. Eleven percent of the 2,340,000-ton total sediment influx from the drainage area upstream of Lake Pepin is 260,000 tons as shown in Exhibit 66. The reader should be careful not to "double-count" the sediment passed from one pool to the next. As a settling basin, Lake Pepin is far superior to downstream backwaters areas because of its longer detention time and negligible velocities. Therefore, materials passing through Lake Pepin are unlikely to encounter conditions further downstream which are more conducive to settling out.

Comment (12, 17): The EIS includes a discussion of the effects that the Chippewa River has on the Mississippi River. In using the data given in the EIS a calculation would show the Chippewa to cause up to 37% of all the material dredged in the St. Paul District of the Corps. This is somewhat different from the EIS calculation which is 20%. Our calculations indicate that the Chippewa River does cause over 1/3 of all the dredging performed in the District. If a program were intensified in alleviating problems caused by the Chippewa, the total amount of dredging needed could be significantly reduced. Such a program should include a sediment trap, semi-permanent disposal capability, a confinement site located to facilitate commercial use of the dredge spoil, permanent disposal capability, a Chippewa basin sheet, gully erosion control program, and a Chippewa basin bank erosion control program.

An evaluation of the benefits of such a program should include a study of its potential for reduction in erosion and sedimentation, savings in agricultural productivity, reduced erosion of stream banks, and damage to roads, buildings and other private and public property, improved water quality, and reduced degradation of ecologically sensitive backwater areas.

The position taken in the EIS that unsatisfied bedload carrying capacity caused by control measures on the Chippewa would cause bank erosion problems

on the Mississippi raises the question of where such bank erosion might occur and what potential for damage there might be. This should be developed fully in the final EIS.

Response: The 37-percent figure used in the comment apparently was incorrectly derived by comparing the average annual amount of sediment dredged in pools 4(below Lake Pepin), 5, 5A, and 6 with the total amount dredged in the St. Paul District. This method assumes that the sole source of materials requiring dredging in these pools is the Chippewa River. This fails to recognize that there are other sources of bedload materials contributing to the quantity requiring dredging. In addition, this method includes pool 6 dredging quantities, whereas later in the EIS discussion it is indicated that pool 5A is likely the downstream limit of Chippewa River sedimentation effects. The EIS figure of 20 percent was derived and confirmed by two independent methods both of which make use of the sediment yield procedure which is presented in the Upper Mississippi River Comprehensive Basin Study and used in the trap efficiency calculations.

We concur with the opinion that reducing the sediment contribution of the Chippewa River would reduce dredging quantities, if not immediately, then certainly on a long-term basis. Alternatives designed to accomplish this are discussed in Section 6, including sediment barriers and watershed land treatment measures. Many of these alternatives, however, lie outside the purview of the Corps of Engineers and would require a change in authorization for the Corps or a major involvement by agencies in the agricultural and soil conservation fields.

Time constraints and a lack of adequate data combined with the limited state of the art of sediment transportation engineering make it impractical to do more than recognize the possibility of bank erosion problems in this EIS. If detailed studies of sedimentation problems and solutions are authorized and funded at some future date, it may be possible to conduct model studies to more accurately assess the bank erosion potential.

Comment (18): Page 84, Item C - It is stated that the Chippewa River is responsible for about 20 percent of all maintenance dredging in the St. Paul District, and about 93 percent of the total sediment load of the Chippewa River comes from the reach of the stream between Eau Claire which includes only 17 percent of the drainage area. Samples of spoil sites show that Chippewa River sediments are carried at least to pool 6. Since pool 6 was the lower end of sampling for Chippewa River sediments, it is probable that these sediments may be carried further downstream, and that the Chippewa River may be the major contributor of sediments below Lake Pepin. If measures were taken to control stream bank erosion, it is stated that in dredging pools 4, 5 and 5a could be reduced by 35 percent. This estimate seems rather conservative since reductions in sedimentation could also occur further downstream than pool 6.

Response: It is true that the finer suspended Chippewa River sediments would not appreciably affect dredging requirements. It is the movement

of bedload materials that is of prime concern from a dredging point of view. Studies conducted in preparation of this EIS indicate that the downstream limit of movement for Chippewa River bedload most likely is pool 5A, although there is some question about these materials reaching pool 6. Regardless, instituting bank erosion control measures along the Chippewa River to reduce bedload quantities would affect dredging only in pools 4, 5, and 5A, and possibly 6.

Comment (10): Page 85 - Item d - The Mississippi River is not at "near equilibrium" unless the dredging operation is considered part of the natural stream situation. Suggest changing first half of second sentence to "If the channel dimensions are maintained so as to be basically the same from year to year,---"

Response: As the comment suggests, the assumption of "near-equilibrium" does include the effect of dredging operations in maintaining the sediment balance of the pools. This is clarified in the final statement on page 65.

Comment (6): Item (d) on page 85 discusses the nature of the stream bedload. We question the basis for assuming the Mississippi River to be in near equilibrium with the present rate of incoming sediment. The data presented do not support such an assumption. A possible contradiction exists between information presented in the second paragraph on page 79 and the narrative interpretation of Exhibit 66 presented on page 85. Since bedload is the only material dredged, if the average bedload carried by streams in the Upper Mississippi River Basin averages 10 percent of the total sediment transported (page 79), and an average of 7 percent of total incoming sediment is dredged (page 85), then the Corps actually dredges 70 percent of the bedload. This means that, either the dredging activities are of a greater magnitude than stated in the EIS or calculations of trap efficiency are based on inaccurate data.

Response: The amount of bedload which a river carries can vary a great deal from stream to stream. Quantitative measurements of such sediment is extremely difficult. Keeping this in mind it is important to realize that only general comparisons can be made between bedload transport and dredging quantities on the Mississippi River. The comparison of the 10-percent figure and the 7-percent figure on page 85 of the draft statement was made only to check the reasonableness of the two values in relation to each other. A difference of three percent is entirely within the range of accuracy of the basic bedload data available for use in the study and indicates a very good comparison.

Comment (18): Page 86, First Paragraph, Fourth Sentence - The capability of the Mississippi River in this reach to move the bedload supplied by the Chippewa River can be attributed to the numerous wing dams shown in Exhibit 37 rather than through natural causes. These wing dams acting in concert with dredge spoil material deposited along the main channel have contributed to the degradation of the Nelson-Trevino bottoms.

Response: The natural braided configuration of the Mississippi River probably developed the capability of transporting the sediment influx from the Chippewa River. However, a braided configuration usually consists of shallow channels subject to frequent lateral migrations, making the natural situation generally unsuitable for a viable navigation system. Wing dams and closing dams can be used to narrow the flow area, thereby increasing velocities and depths. In addition, wing dams stabilize the channel location by preventing lateral movement. Accordingly, the wing and closing dams below the confluence of the Chippewa and Mississippi River would appear to play a significant role with regard to bedload movement with the present modified channel configuration. The text of the final EIS has been modified to reflect this point on page 65.

Comment (6): In order to fully evaluate the retained capability of the river for carrying most of the bedload 3 miles downstream from the mouth of the Chippewa River, this section should discuss the impacts of the many man-made structures, such as 40 to 50 wing dams, the highway bridge and numerous developments along the shoreline. The capability to carry sediments is a forced capability, not the natural capability implied in the statement.

Response: See previous Comment/Response.

Comment (26): Pages 86-89 - This should definitely be resolved by further study.

Response: Concur.

Comment (6): A major fallacy exists in the sampling design used to obtain data for Exhibit 71 referenced on page 88. Natural gradation of the material on a spoil site occurs from wind and water erosion. The larger particles remain as the fines are washed or blown from the site. This would tend to distort the percentages of particle size toward the larger sizes.

Response: These gradation results were included to illustrate the general nature of the type of material being dredged. However, as the comment notes, one must recognize that the tabulated data do not accurately reflect the gradations of in situ material. The placement of spoil by hydraulic dredging tends to wash out fines as does subsequent erosion of the spoil pile by wind and water erosion. An attempt was made to compensate for the migration of fine materials downslope by collecting samples at the top, middle, and toe of the spoil pile and averaging the gradations. However, these preliminary test results should be considered approximations because of the numerous factors affecting the gradation samples.

Comment (18): Page 88, First Paragraph, Last Sentence - This sentence seems to indicate that the data contained in Exhibits 67, 68, 70 and 71 are statistically meaningless for comparison or for drawing any conclusions.

Response: Two sets of samples were collected and tested independently of one another. Because the two sets employed different methods of collecting and testing samples, a direct comparison of the test results of the two sets is not recommended. However, consistency of sampling techniques and locations and testing procedures with each set makes a comparison of individual sample results within each set quite valid and helpful.

Comment (18): Page 89, First Paragraph - It is indicated that Exhibit 69 may show that sediments in pool 6 more closely resemble those from the Trempealeau River rather than the Chippewa River. A review of this exhibit does not necessarily lead us to the same conclusion. Thus, it would be necessary to provide the studies and sampling data in the Environmental Impact Statement in order for us to make a determination in this regard.

Response: Exhibit 69 indicates that the pool 6 gradation may more closely resemble that of the Trempealeau River in the larger grain sizes, but is more nearly like the Chippewa River gradation in the finer grain sizes. Obviously, further studies would be needed to settle this issue. Several related problems could be addressed by such studies. For instance, no satisfactory method has been developed for collecting truly representative and comparable samples from spoil piles, riverbanks, and riverbeds.

Comment (18): On pages 91 and 92 it is concluded that the sediment yield of the Chippewa River, based on past dredging records, may be only 300,000 cubic yards. The sediment yield of the Chippewa River may be larger if the studies were to show that sediment from the Chippewa River is being dredged farther downstream than pool 5A. On the bottom of page 22, the "experiment" performed in 1965 where 314,000 cubic yards of sediments were removed from the mouth of the Chippewa River is explained. Since the sediment trap filled up, it was assumed that the volume of the sediment trap was equal to the Chippewa River bedload contribution. It is our conclusion that this estimate is not valid since there was no continuous monitoring and the control of the study was extremely poor. It is very possible that the sediment trap may have filled up quite rapidly which allowed a large volume of sediments to bypass the sediment trap and continue downstream. We are unable to find any definitive information in the draft Environmental Impact Statement which proves or disproves this point; therefore, since the bedload contribution of the Chippewa River is in question, the value of maintenance dredging at the mouth of the Chippewa River must be reexamined.

Response: This single experiment obviously did not satisfactorily determine the quantity of bedload delivered to the Mississippi River by the Chippewa River. Three alternatives are possible:

1. The quantity delivered may have been less than the quantity dredged. According to engineers experienced in the sediment transportation field, two processes are involved in filling a hole dredged in the bed of a river, local bedload movements and normal bedload transport. Dredging a hole in the riverbed induces an immediate movement of bed materials in the vicinity (such as by sloughing) as the river seeks to

reestalish its natural cross section. This movement is not related to normal bedload transport which continues at its natural pace, eventually filling the remaining volume of the hole.

2. The quantitity delivered may have been more than the quantity dredged. If only a short period of time was required by either or both of the processes discussed above to fill the hole, a quantity of bedload far in excess of that needed to fill the hole could have been transported past this point undetected.

3. The quantity delivered may have been approximately equal to the quantity dredged. Several methods were used in the EIS to estimate the quantity of bedload transported by the Chippewa River. The resulting average figure (422,000 tons) represents the best available estimate and, coincidentally, compared very favorably with the quantity of material dredged in the Chippewa River experiment (424,000 tons). Although this similarity of results seems to lend some degree of credence to this third alternative, further studies would be advisable to more conclusively establish the bedload contribution of the Chippewa River.

Comment (6): Sufficient data are not presented to verify the computations on sediment. We note that the total average annual dredging for all pools equals 1,934,000 tons per year (Exhibit 66). Using 1.35 tons per cubic yard (page 93), the average annual dredging equals 1,432,000 cubic yards per year, but an average of 1,600,000 cubic yards is given on page 20.

Response: The figure of 1,432,000 cubic yards is based on the dredging during the period 1956-72, which includes several years of comparatively small amounts of dredging in the St. Paul District (example: 1961-480,000 cubic yards). The figure of 1,600,000 cubic yards for the DREDGE THOMPSON is based on only the last five years of this period during which time St. Paul District dredging was somewhat greater than the long-term average.

Comment (10,6): Page 93 - We question the assumptions regarding Exhibit 75 on the dredging trend in the St. Paul District. It appears that much of the high-volume dredging in the 1930's would have to have been associated with original development of the 9-foot channel rather than O & M, and that a significant amount of the dredging volume in recent years was due to overdepth dredging to 11- and 13-foot depths to accommodate larger towboats and to allow for less frequent dredging. It would be more accurate to label the section "Dredging Trends" since "Trends" suggests a discussion of natural sedimentation trends.

Response: The text of the EIS has been modified on page 69 and following to discuss many of the factors brought out by this comment.

Comment (18): Page 93, First Paragraph, Third Sentence - The indication of a trend toward less dredging in relationship to river discharge indicates that the navigation channel is becoming increasingly more hydraulically

efficient. Dredge spoil disposal in combination with secondary movement from the existing dredge spoil sites and wing dams would appear to be responsible for the increased hydraulic efficiency of the channel. If the channel has become more hydraulically efficient, this would explain why the backwater areas are aging and filling with sediments. Should this process continue into the future, it could only be expected that the value of much of the Mississippi River resource would decline.

Response: The trend toward less dredging in relation to river discharge may be related to the apparent increase in hydraulic efficiency of the main channel discussed earlier in this section. This could increase the river's bedload transport capabiltiy and thereby reduce dredging requirements. However, the secondary movement of dredge spoil would not be the agent responsible for this increased efficiency as suggested in the comment.

The increased efficiency of the main channel may or may not be a significant factor contributing to backwater sedimentation. If the main channel is more efficient, presumably the amount of flow and therefore the velocities in the backwater areas would be reduced. The reduction in velocity would cause a greater portion of the suspended particles to settle out, but offsetting this would be the reduced quantity of sediment-laden water reaching the backwater areas. The net effect is unknown at present.

Comment (6): The statement also should discuss the use of the DREDGE THOMPSON in the Rock Island District, possible completion of dredging to the project depths in the late 1940's and impacts of drought or high water as it influences volumes dredged. The statement gives no consideration to the fact that, if the last 15 years were given a trend line, it would go upward sharply.

Response: The text of the EIS has been modified on page 69 to discuss the factors brought out by this comment.

Comment (26): Page 93, Paragraph 2 - Is this twice the work load? What effect does this have on the amount of dredging?

Response: The text of the EIS has been modified on page 69 to expand the discussion which gave rise to this question.

Comment (18): Exhibit 75 shows a gradual decline in the quantity of sediments dredged versus cumulative annual discharge for the Mississippi River at McGregor. Information should be provided which would explain why the ratio declined until the 1950's at which point it stabilized. We would like to know if the Corp's dredging policy changed at this time to dredge to deeper depths, to perform dredging at an earlier time, or to somehow change the dredging operation. We would also like to know if the planned operation of the DREDGE THOMPSON may be responsible for the stabilization. It could also be possible that since the amount of dredging has stabilized the Corps is actually performing unnecessary dredging either by dredging areas before they really become a problem or by overdreding to 13 feet rather than 12 feet or some lesser depth. Some locations may stabilize at 10 or 11 feet, but as a matter of practice are overdredged anyway.

Response: The text of the EIS has been modified on page 69 to discuss the factors brought out by this comment. As discussed in Section 5 of the draft EIS, commercial craft using the 9-foot navigation system actually require about 11 feet of depth in order to prevent windrows of sediment due to propwash from fanning and blocking the channel. Although some locations might appear to stabilize between 11 and 13 feet in any single year, sedimentation in subsequent years could not be considered predictable. Sediment deposition is a function of numerous interrelated factors:

1. Characteristics of the drainage basin, including topographic features, types of soils, and extent of vegetal cover.

2. Weather factors, including depth of frost; quantity of snowfall and snowmelt schedule; date, location, intensity, and direction of rainfall.

3. Hydraulic factors, including size and timing of peak flows on the Mississippi River and its tributaries.

The almost infinite variability of these factors makes it almost impossible to predict future sedimentation with any degree of accuracy. The economic risks involved in allowing a site to stabilize naturally are high and include potential costs for delays to commerical navigation plus the costs of unscheduled emergency dredging by the DREDGE THOMPSON. More detailed discussion can be found in Section 6 of the final EIS.

Comment (5): The opening discussion of Sedimentation, under Sediment sources, includes the statement that "Sediment results from natural processes...." It is not until four pages later that one reads: "The present sediment situation in the Upper Mississippi River Basin probably reflects a combination of natural and man-induced influences." Is there really any doubt on the latter statement? The third paragraph which follows that statement sounds more positive.

Response: "Sediment results from natural processes of weathering and erosion," as stated in the EIS. However, man'a activities contribute to the problem by exposing more soil to those natural processes or otherwise making these natural processes more efficient through poor agricultural practices, unprotected road cuts, etc.

Comment (24): The statement should include an analysis of habitat and habitat changes plus the effects of these changes on terrestrial and aquatic organisms at given periods since the project was started. In the case of aquatic habitat there should be a statistical analysis showing any relationship among river flow, river temperature, and water chemistry data. Aquatic studies also should include a study of light effects in relation to turbidity and other factors on river organisms. For both terrestrial and aquatic organisms there should be a thorough inventory of species, including micro-organisms. Statistical analyses should show temporal and spacial distribution of all species plus ecological relationships of populations. The results of those studies should be statistically correlated with relevant physical and chemical data.

Without these kinds of studies and correlations, it is an open question whether the requirement of NEPA for the environmental assessment of this project has been met.

Response: Data regarding the revegetation of dredge spoil material to include those species most likely to be successful as well as the "value" of the resulting habitat is presently being investigated under contract. A second contract also active at this time is generating, via the interpretation of various types of remote sensing imagery, data pertaining to the acreages of various habitat types, spoil deposits, etc. Baseline maps will be developed which delineate these acreages in 1973 and 1939. This information will be made available as soon as it is received.

Comment (18): Page 94, Biological Aspects of the Study Area - We find that there has been little original research or documentation of plant and animal communities which are being affected by the operation and maintenance of the 9-foot channel. Most of the information which is presented has been obtained from other sources.

A better understanding of the ecology of the study area could be presented by relating the relative densities of the various species to the different types of habitats. This is particularly important for rare or endangered species. It would be helpful to know where cormorant nesting sites are located, and what habitat is critical for their survival. The same analysis should be done for eagles. In addition, the impact of channelization and dredge spoil disposal on endangered species should be evaluated.

In order to make this section more meaningful, information should be provided on this historical plant and animal communities. The impact of the construction of the locks and dams and operation and maintenance of the project on previously existing plant and animal communities should be evaluated.

Response: Original research was conducted under contract with North Star Research Institute for all of the navigation pools on the Upper Mississippi River within the St. Paul District. The results and/or documentation are contained within the Environmental Impact Assessments. Additional information was derived from reputable sources such as Curtis, 1959 - The Vegetation of Wisconsin, and publications of various State and Federal agencies.

Relating relative densities of animal populations with various habitat types would be a formidable task and not feasible until a complete understanding of the ecology of the Upper Mississippi River was achieved. Research is currently being conducted by various agencies and it is hoped that a higher level of knowledge will eventually provide a basis for sound resource management.

Significant populations of nesting cormorants or bald eagles are not known to presently exist within the navigation pools of the Upper Mississippi River. It is possible that small numbers of these species nest in the Upper Mississippi River, however, we found no documentation as to the location of active nesting sites.

Further consideration of historic plant and animal communities and the impacts of lock and dam construction, other than previously addressed in the draft EIS, would detract from the original intention of the statement. The statement's primary intent is to address the environmental impacts and effects of the operation and maintenance of the project.

Comment (25): We are treated to an extensive inventory of the different types of fish and vegetative and waterfowl species, but all of this is meaningless without a discussion of the trends exhibited by each, the effects on biological productivity, the effects of intrusion of different fish and plant species, or the effect of the operation on the food chain in the river. A discussion of the life found in the river prior to impoundment would also have been useful in making evaluations.

Response: The assumption that adequate definitive ecological data exists on which an analysis of population fluctuations or trends can be made is incorrect. Current research programs being conducted are attempting to reveal these facts. It is believed that an adequate amount of discussion was presented dealing with preimpoundment conditions. The limitations on the amount presented was governed both by the lack of available materials and because the EIS was orientated towards impacts of operation and maintenance.

Comment (11): Page 94, First sentence, reference to Exhibit 77 - The diverse zones of vegetation and the listed "common" species may show general and broad values. However, the various habitats and "edge effects" can be important to many other wildlife species. The following should be considered as a qualifying statement on that Exhibit. The importance is seasonal or intermittent depending on the season. An example is the importance of oak forests or wood lots as food for wood duck and deer. Another example is the importance of all marshes or wetlands to many waterfowl species - not just mallard and teal. Other waterfowl species remain as residents and many migratory birds (including waterfowl) use all types of wetlands for courting, food, cover, nesting, and loafing.

Response: Concur. The following sentence was added on page 71 of the final EIS to qualify Exhibit 77: "Recognizably, wildlife-habitat associations are seasonally dependent, as well as correlated with, vegetative continuity, successional stage of development and juxtaposition of habitat types."

Comment (18): Exhibit 77 - Otters should be listed as a species inhabiting both deep marshes and shallow marshes. The white-tailed jack rabbit and Hungarian partridge inhabiting the prairie grassland would be considered as being rare in Wisconsin.

Response: Otters have been included in the subject exhibit. While the white-tailed jack rabbit and Hungarian partridge are considered rare in Wisconsin they are not considered rare in the "study area".

Comment (26): The information in the section on pages 95-106 of the draft EIS is confusing. It would benefit by being arranged by pool as in the following section.

Response: Comment noted. However, we disagree with your opinion.

Comment (6): The Environmental Setting--Terrestrial Vegetation Section should address the relative values of the vegetation that can be established on spoil deposits. This discussion should include the percent of ground and crown cover as well as the species that make up those ecotones.

Response: Concur. The potential revegetation or vegetation of dredge spoil material is presently under investigation. See also the following Comment/Response.

Comment (6): Vegetation types and revegetation are discussed in several sections of the statement. However, the relative values of the habitat types are not compared or otherwise discussed. Supportive data for information given are not referenced or substantiated. Acres of the various habitat types from early aerial photographs as compared to 1973 aerials would have been useful.

Response: Data regarding the revegetation of dredge spoil material to include those species most likely to be successful as well as the "value" of the resulting habitat is presently being investigated under contract. A second contract also active at this time is generating, via the interpretation of various types of remote sensing imagery, data pertaining to the acreages of various habitat types, spoil deposits, etc. Baseline maps will be developed which delineate these acreages in 1973 and 1939. This information will be made available as soon as it is received.

Comment (10): Page 96 - The average reader would find use of common names of plants and trees in Exhibits 78 - 83 much more meaningful than scientific names. (See Exhibit 84 as example). It would help to group species by families in Exhibit 79 to parallel the reference in the text.

Response: Concur in reference to the addition of common names. The subject Exhibits have been changed accordingly in the final EIS. Grouping of species by families is not believed necessary. Tree species are ranked according to Average Importance Value while herbaceaus plant species are listed alphabetically.

Comment (18): Page 98, Third Paragraph, Last Sentence - It should be pointed out that all of the species listed are scarce expect for river birch.

Response: Concur. The following sentence has been added on page 73 of the final EIS: "With the exception of river birch, however, these species are relatively scarce."

Comment (6): Reference is made to the tap root developed by cottonwoods (page 101 and 103). This is incorrect since cottonwoods have a small tap root and a large superficial root system.

Response: Concur. The subject portions have been deleted from the final EIS.

Comment (18): Page 102, Second Paragraph, Second and Third Sentences - The value of vegetation that colonizes dredge spoil sites should be evaluated for its importance to man and wildlife. It has been our experience that the dredge spoil sites do not revegetate for many years after the spoil has been placed. An evaluation should be made on the length of time it would take for a dredge spoil site to naturally revegetate.

Response: Concur. These data are presently being gathered and evaluated under contract and will be made available as soon as they are received.

Comment (18): Page 102, Second Paragraph, Last Sentence - It should be specified that the recreational users of dredge spoil sites are mainly campers, picnickers, swimmers, and boaters. We would question whether these sites receive the most recreational use of the total land area in the pools. It could be exptected that bank fishermen and waterfowl hunters would also account for a substantial amount of recreational use on certain lands.

Response: Concur. The subject sentence has been modified such that "most use" is changed to "considerable use" on page 75 of the final EIS.

Comment (18, 10, 6): Page 103, Last Paragraph, First Sentence - We would question whether terrestrial vegetation has not significantly changed since inundation by the locks and dam. A considerable amount of terrestrial vegetation has already been altered by dredge spoil disposal. This has resulted in several dredge spoil areas of large size having little or no existing vegetation. Sedimentation of backwater areas has resulted in the conversion of wetlands and open water areas to upland. Based on the past changes, we would expect that there is far more terrestrial vegetation at the present then there was at the time of inundation by the locks and dams. The creation of the impoundments has had a significant impact on terrestrial vegetation.

Response: Subject discussion has been modified on page 75 of the final EIS. The intent of the discussion was relative to the alteration of species composition of various vegetation types, which is not believed to be

significant.

Concur to the remaining portion of the comment dealing with the overall increase in proportions of terrestrial vegetation in backwater areas as a result of sedimentation.

Comment (18): Page 104, First Paragraph, Seventh Sentence - Common elder is also known as elderberry.

Response: Concur.

Comment (25): On page 105, paragraph 1, Shrub-Carr community should be explained.

Response: As defined by Curtis (1959) in Vegetation of Wisconsin, page 353, "The shrub-carr is considered to be a wet-ground plant community dominated by shrubs other than alder with an understory intermediate between meadow and forest in composition."

Comment (11): Page 105, Second Paragraph , Third Sentence - Qualify this statement. Through continuous commercial development and increased runoff and flood problems, development of most land in the valley, on terraces or not, has directly or indirectly affected the river. All development on a floodplain has some effect on the river. Considerable commercial development has occurred on lands that are not terraces or on terraces very close to the river. A terrace as stated in the report should be defined.

Response: In reference to historic development, there can be little doubt that bottomland development has changed relatively less than the upland praire or forest which has been essentially replaced by croplands or intensively pastured lands. A terrace as used in this context is an area representing a previous, geologically older, riverbed which is somewhat removed and varied above natural, present day river levees. Subject sentence has been modified, however, and included in the final EIS on page 76.

Comment (6): The habitat described in the table on page 106 of the draft statement should correspond to USDI--Fish and Wildlife Circular 39, Wetlands of the United States, and the discussion should be correlated around these established habitat types.

Response: Appropriate changes have been made on page 77 of the final EIS.

Comment (10): Page 106 - While it is true that an increase in island formation and expansion of terrestrial habitat have occurred due to wing and closing dam effects, the corresponding reduction of open water, marshes and wooded swampland habitat should be acknowledged in this section. Cattail is not a common species of deep marshes.

Response: Concur. Subject of comment is added to the text on page 77 as follows: "Any increase in terrestrial habitat is realized as a result of a decrease in aquatic habitat." Cattail has been deleted from the deep marsh habitat listing.

Comment (11): Page 107, Pool 2 (aquatic vegetation comments in Pigs Eye Lake)- Although aquatic vegetation is limited in the lake, it should be noted that if pollution and turbidity were reduced, marsh habitat and aquatic vegetation would be of better quality and quantity as in earlier times.

Response: Comment noted.

Comment (6): The reference to high phytoplankton densities of 1964 on page 108, should be either expanded to relate it to the rest of the topic or deleted.

Response: Concur. The subject reference has been deleted from the final EIS.

Comment (18): Page 108, Third Paragraph, Fourth Sentence - We would question whether watercress would be found in the protected backwater areas of the St. Croix River since this aquatic plant is typically associated with cold spring water sources.

Response: Concur. Watercress has been deleted.

Comment (17): Exhibit 82 - Scripus should be spelled Scirpus and Saliz should be spelled Salix.

Response: Concur. Correction included in subject exhibit.

Comment (28,6,10,11): Page 112, Paragraph 3 - "Lack of marsh and aquatic plants is no longer a problem." This statement, from a report dated 1960, by William Green of the USFWS, is accurate in context of the report as written in 1960. However it contradicts other data in the Environmental Impact Statement which outline damage being done to backwater areas, particularly the Weaver Bottoms (see pages 315-321). It is generally agreed upon by trained aquatic biologists that the aquatic plant communities have changed considerably since 1960 in some pools, especially pool 5. The statement should provide information indicating past and current trends in habitat changes. This is essential before in-depth analyses of impacts of future O&M can be made. The statement of Dr. Green's should be footnoted in the final statement to reflect this fact.

Response: The subject section is presented as a general statement of conditions. It is believed that adequate reference is made throughout the text relating to deteriorating areas and vegetation.

Although outdated, Dr.Green's report was presented because it was believed to be the most comprehensive and accurate statement on vegetation in pools 4 through 10 available. Updating of the vegetation description will be possible after completion of ongoing habitat studies.

Comment (18,4): Page 116, First Sentence - This listing of aquatic plants in pools 4 and 9 is obviously out of date since it is over twenty-seven years old. Considerable habitat changes have taken place since this survey was completed. For instance, Valisneria is listed as having a trace of a percent of occurrence. It is known that there are considerable beds of this particular plant in pool 7.

Response: As noted in the text, the reference to aquatic vegetation in pools 4 through 9 was dated 1960. However, Dr. Green's report is considered the best overview of aquatic plants presently available. Additional fragmentary data can be found in the individual pool assessments. A more detailed and updated report will be available following completion of current investigations.

Comment (10): Page 116-148 - To provide for better comparative analysis of activities and values with other uses, all references to harvests or catch of mammals, birds, reptiles, amphibians, fish and aquatic invertebrates should be presented and summarized in the socioeconomic setting area of the report, not as fragmented citations in the Biological Aspects of the Study Area. Such information should be updated and expanded to more fully represent current values.

Response: Data pertaining to the harvests of mammals, birds, reptiles, amphibians, fish and aquatic invertebrates is recognized as appearing fragmentary. This is due to the fact that information regarding the various harvests for each pool is either unavailable or nonexistent. Subsequently, it was believed that a presentation of whatever material known or available whenever possible was the best approach for presenting as detailed and complete an EIS as possible.

Comment (11): Page 117, Lines 10-13 - We have no documented evidence that a moose was killed near Houston a few years ago, nor of one being sighted near Hastings in 1973. A moose has been seen this past year in the vicinity of Stewartville, which is south of Rochester, Minnesota. A bull elk was shot near Caledonia in 1964.

Response: Subject information included on page 85 of the final EIS.

Comment (11): Page 117, Lines 13-15 - This statement is in error. Two mule deer were shot within 5 miles of each other during the last 2 deer hunting seasons. One was shot in western Houston County and the other in eastern Fillmore County.

Response: Subject information included on page 85 of the final EIS.

Comment (17): Exhibit 84, Page 86 - Gray fox would be considered as occasional rather than common, and river otter would be considered as common rather than occasional.

Response: Modification has been made in the subject exhibit.

Comment (11): Page 118, Line 4 - Our records show one nutria was trapped in the early 1960's near Etter, pool 3.

Response: Subject material has been added to page 86 of the final EIS.

Comment (11): Page 118, Line 10 - According to our game biologists, cottontail rabbits are not common in the Minnesota portion of the Upper Mississippi River Valley.

Response: Comment noted. However, the sentence refers in general to the Upper Mississippi River, including Wisconsin and Iowa.

Comment (11): Page 118, Lines 13-16 - We have not recorded the presence of snowshoe hares in any of the upper pools.

Response: Subject sentence has been modified to "reported but unsubstantiated", on page 86 of the final EIS.

Comment (11): Page 118, Lines 20-23 - The black bears observed in the Whitewater Wildlife Management Area were released there as cubs by person(s) yet unknown. To the best of our knowledge, there is no natural reproduction of bears occurring in this area.

Response: Subject material has been included on page 86 of the final EIS.

Comment: Page 120, Paragraph Two - This section is incomplete since no mention is made of the value of wetlands and marshes to aquatic furbearers and of the economic value of the animals which are harvested. An indication should be given on the current value of aquatic furbearer pelts. An assessment should be included on the effect of dredge spoil disposal in sloughs and marshes on reduced furbearer populations.

Response: Economic values attributed to aquatic furbearers are contained in the section "Commercial Fishing and Trapping"(page 178 of the draft EIS). Assessment of impacts of dredge disposal in marsh and slough quality is amply covered throughout the text. A reduced quality of any habitat type also logically infers to the reader a reduction in populations of associated and dependent species.

Comment (10): Page 121 - Passing reference is made to the "national and international significance" of the Mississippi River for migratory birds. This section deserves to be greatly expanded to quantify such significance in national and international terms, especially as regards waterfowl. This section should be coordinated with the Bureau of Sport Fisheries and Wildlife in view of its refuge knowledge and responsibilities and should include the same kind of data available in Appendix B of the St. Paul District Master Recreation Plan, Part I (1965), e.g. 14,931,000 Duck Use Days, 1957-1961.

Response: Further elaboration on waterfowl and associated significance, locally and nationally, are presented on pages 88-90 of the final EIS.

Comment (18): Page 122, First Paragraph - It is our opinion that this section should be expanded to include an evaluation of the importance of backwater areas to waterfowl. The effect of dredge spoil disposal on the continued use of backwater areas by migrating waterfowl should be evaluated. The value of waterfowl hunting to the area economy should also be included by discussing the number of hunter trips and their success rates.

Response: The general importance of backwater areas to waterfowl was added to page 88 of the final EIS. Effects of dredge spoil disposal are more appropriately treated in the Environmental Impacts section. Values of waterfowl hunting are treated in sufficient detail on page 134 of the final EIS in the subsection of the Environmental Setting entitled "Recreation".

Comment (11): Page 122, Second Paragraph, Page Three - Canada geese are mentioned as users of the Mississippi River; however, no mention is made of blue and snow geese although Exhibit 88 lists these birds as common migrants.

Response: Subject material has bee included on page 89 of the final EIS.

Comment (18): Page 122, Last Sentence - The statement is made that "The geese have responded to specific refuges so that most of the population now to Necedah, Wisconsin." Actually few geese go to Necedah. It was probably intended to mean that they go to the Horicon National Wildlife Refuge, although this is questionable since banding information shows that a sizable portion of the Canada geese migrating down the Mississippi River are associated with the eastern prairie population which winter in Missouri. The Mississippi Valley population passes through Horicon and winters in southern Illinois.

Response: Subject sentence has been modified on page 88 of the final EIS.

Comment (6): The reference to hunter success and hunter trips (page 122) should be expanded and would be more appropriately addressed in the section on recreation. Clarification is needed as to what goose population is being discussed. The statement indicates that most geese stop at Necedah Refuge but does not mention the very important Horicon flock. The discussion on wood ducks is not entirely accurate. For example, the statement that ducklings are unable to cross railroad tracks is incorrect. Broods can and do cross the railroad tracks.

Response: Concur. Subject material included on page 89 of the final EIS.

Comment (11): Page 123, Lines 4-5 - The giant Canada geese wintering at Rochester have not, at least according to our observations, used the Mississippi River to any great extent, as the report implies. The present wintering population numbers 12,000 - 15,000 birds.

Response: Appropriate changes have been included on page 89 of the final EIS.

Comment (26): Page 123, Paragraph 3 - Since the park is at the backwater area downstream of Hennepin Island, replace "In addition" with "There..."

Response: Sentence has been changed from "In addition, at Father Hennepin Bluffs Park, several..." to "At Father Hennepin Bluffs Park several..." on page 89 of the final EIS.

Comment (10): Page 123 - Geese in the Mississippi Flyway are responding to both Horicon and Necedah National Wildlife Refuges in Wisconsin; Rend Lake should be added to the southern Illinois refuge list.

To avoid possible understatement, it should be noted that recorded members of nesting ducks are based on actual observation and the total nesting population is certainly much higher.

Response: Subject material has been included on page 89 of the final EIS.

Comment (11): Page 124, Lines 2-3 - The large number of wood ducks in the harvest is due to its abundance locally, as well as hunter preference and vulnerability.

Response: Subject information has been included on page 90 of the final EIS.

Comment (18): Page 124, Third Sentence - The statement is made that wood duck ducklings are unable to cross railroad tracks. This is a misleading generality. Newly hatched ducklings may not be able to cross railroad tracks; however, older broods, which are still classified as ducklings, have no such problem.

Response: Subject material has been included on page 90 of the final EIS.

Comment (10): With reference to page 125, Hungarian partridge are also found on agricultural lands. Woodcock use the valley extensively during their migrations and nest primarily in moist, wooded uplands.

Response: Concur. Subject material included at indicated location on page 91 of the final EIS.

Comment (26): With reference to page 125, paragraph 1, herons and egrets are viewed other seasons, too.

Response: Concur. Subject sentence has been altered accordingly on page 90 of the final EIS.

Comment (6): The section on predatory birds, page 125, is not correct in its discussion on eagles, since eagles also winter below locks and dams 8 and 9. Except for the foot of Lake Pepin there are often higher numbers

below locks and dams 8 and 9 than anywhere else in the St. Paul District. The 1-day eagle count on January 16, 1974, showed only 15 eagles in pools 4, 5, 5A, and 6, while pool 9 had 32. The final statement should include this information.

Response: Subject information has been included on page 90 of the final EIS.

Comment: Exhibit 86 - Moose and bear should be excluded from this exhibit. Also, the snowshoe hare is rare, if present at all.

Response: We disagree. The notation that the moose and bear are "rare" but documented for the area is considered more correct than their exclusion from the exhibit.

Comment (11): Page 126, Lines 13-16 - The ruffed grouse is much more common than either the pheasant or quail.

Response: Comment noted. However no direct statement was made in regards to relative abundance of ruffed grouse to quail and/or pheasants.

Comment (10): Page 128 - Since the statement notes "26 kinds of ducks" in pool 3, the references to "a few waterfowl species" are understated and should be changed to "numerous waterfowl species."

Response: Modification has been included on page 92 of the final EIS.

Comment (26): On page 128, paragraph 3, after "...eagle" add "--an endangered species--".

Response: Subject material has been included on page 92 of the final EIS.

Comment (18): Pages 129 to 130 - This entire discussion presumes a waterfowl population that was the same each year, which is not true. Many other factors for controlling population levels were involved including overshooting, pothole drainage, development of alternate rest-stops for geese, etc. The river bottom in its preimpoundment condition could have attracted as many waterfowl, or fewer waterfowl, depending upon local conditions were low throughout the summer and flooded in September, thousands of acres of annuals such as Bidens were inundated, which made for excellent waterfowl food. The occasional drying out of potholes, marshes and wetlands is also of value to waterfowl habitat. Drying out aerates the soil, and when wet conditions again occur, the aquatic vegetative growth is stimulated especially for such species as Bidens and Polygonum. In total, it is probably true that the impoundment of the Mississippi River favored resting and feeding habitat for waterfowl; however, it also decreased nesting habitat especially for wood ducks. Impoundments also tend to concentrate waterfowl making them more vulnerable to overshooting.

Response: Subject material has been included on pages 92-93 of the final EIS.

Comment (6): The discussion on abundance of ducks on page 129 should be revised. Scaup numbers are lower now than a few years ago; while in the fall of 1973, record high concentrations of canvasbacks were recorded in pools 7 and 8.

Response: Subject discussion has been revised and is included on page 92 of the final EIS.

Comment (6): Although the section on upland game and miscellaneous birds refers to a deterioration of submerged vegetation, the causes of this deterioration are not included. Further discussion of this point is warranted.

Response: Subject discussion is included on page 93 of the final EIS.

Comment (18): Page 130, First Sentence - It is quite possible that the deterioration of submergent aquatic vegetation was due to the severe flooding and resulting sedimentation during the 1960's particularly during 1965.

Response: Concur. Subject information is included on page 93 of the final EIS.

Comment (10): Page 130 - Deterioration of vegetation especially wild celery, has been great in some pools; this influenced pool usage by some diving ducks as well as dabblers.

Response: A reference to vegetative deterioration has been included on page 93 of the final EIS.

Comment (18): Exhibit 89 - The six-lined race runner is considered to be an endangered species in the State of Wisconsin.

Response: The six-lined race runner is not considered endangered within these areas of the Upper Mississippi River Wildlife and Fish Refuge, the area which the subject exhibit addresses.

Comment (10): Page 131 - Snapping turtles, soft shelled turtles, and bullfrogs should be mentioned as species which are locally important along the lower pools, and commonly captured for use as food.

Response: Subject information included on page 94 of the final EIS.

Comment (18): Page 131, Second Paragraph - The fishery section of the Environmental Impact Statement is inadequate and has been mainly treated

in terms of unsupported generalities. It appears that the many UMRCC fishery reports and published Mississippi River papers have been virtually ignored or given cursory consideration in this section.

Response: The fishery section has been revised in the final EIS. The above reports and other sources of information were given full consideration during the revision process.

Comment (18): Page 131, Second Paragraph, Fourth Sentence - The white fishes no longer have family status and are included under the family Salmonidae. Exhibit 90 employs the correct terminology in this regard.

Response: The above sentence has been corrected in the final EIS on page 94.

Comment (26): Page 131, Paragraph 3 - The second and third sentences would be more appropriately placed at the beginning of the following paragraph.

Response: The fishery section has been revised in the final EIS.

Comment (11): Page 131, Fish, Last paragraph, First Sentence - Northern pike are important game fish, but muskellunge are not an uncommon fish in the river above St. Anthony Falls and none are known to exist below the falls.

Response: The fishery section in the "Environmental Setting" of the final EIS has been revised and includes the above information.

Comment (18): Exhibit 90 - The scientific and common names for fish species apparently did not follow the latest American Fishery Society nomenclature (1970).

Response: The source of information for Exhibit 90 is cited on page 104 in the Exhibit Section of the Draft EIS as being from Appendix L, "Fish and Wildlife", Upper Mississippi River Comprehensive Basin Study, 1970."

Comment (18): Exhibit 90, Page 104 - Scaphithynchus should be spelled Scaphirynchus and is known as the pallid sturgeon.

Response: Concur. The correction has been made in the final EIS.

Comment (18): Exhibit 90, Page 105 - The central common shiner is now the striped shiner (Notropis chrysocephalus).

Response: Subject information has been incorporated in the final EIS.

Comment (18): Exhibit 90, Page 106 - The channel mimmic shiner has been dropped as a subspecies. The pugnosed minnow is now Notropis emiliae. The common sucker is the same as the white sucker.

Response: Subject information has been incorporated in the final EIS.

Comment (12): Fish sampling in the area has indicated that there is an increase in the diversity of fish downstream to pool 9. In that water quality does not necessarily improve downstream, explanations are given for such data and include sampling variations (more fish samplings have been taken downstream) and habitat (the pool sand backwaters are more prevalent downstream and create a better fish habitat). Upstream pollution may also be a factor which was not identified in the EIS. In view of this pollution, invertebrate trends presented seem consistent with established trends for a river under such stress conditions.

Response: Comment noted. The final EIS has been revised to reflect the above information.

Comment (10): Page 132 - The American eel (Anguilla rostrata), once common as far up-river as St. Anthony Falls, is now considered rare. Eddy in Northern Fishes attributes their decline to the effects of locks and dams.

Response: The comment has been incorporated on page 95 of the final EIS.

Comment (18): Page 132, First Paragraph - "The Mississippi River" should be omitted as a descriptive term for the paddlefish.

Response: Concur.

Comment (18): Page 134, First Paragraph , Fifth Sentence - The decline of buffalo fish probably resulted from competition with carp or habitat alteration rather than from overfishing.

Response: Carlander (1954) cites three principal factors that could have have been the cause for the decline of buffalo fish:

1. Overfishing coupled with selective fishing pressure (i.e. the buffalo fish is more valuable than carp).

2. Ecological competition with carp.

3. Habitat alteration.

In all probability these three factors were synergistic in effecting the decline of the buffalo fish. The final EIS, on page 96, contains this information.

Comment (18): Page 134, Paragraph Two - It should be stated that impoundment of the river resulted in the inundation of many gravel bars. It should also be mentioned that when the silt was scoured from the channel, it exposed sand rather than rock or gravel.

Response: Mention has been made of the exposure of sand bottom as a result of silt scouring. However, subject sentence in the statement refers to greater exposure of a rock interface of wing dams and riprap.

Comment (18): Page 134, Paragraph Three - Lake and wetland habitat is more important to northern pike than to walleye. Walleye and sauger are able to prosper in a large river environment such as the Mississippi River.

Response: Concur. The change has been made on page 96 of the final EIS.

Comment (10): Page 134 - While wing dams and riprapping have added to rock surfaces and provided feeding grounds for several game fish species, it should be noted that they have tended to concentrate fish in the remaining water areas, with total numbers declining in some sectors due to loss of habitat from extensive sedimentation between the wing dams.

Response: The fishery section has been revised to include the above information.

Comment (4): Page 134 - It would be helpful if the statement indicating that the wing dams provide lush feeding grounds for various species of fish were referenced.

Response: The referenced statement expresses a common knowledge shared by local, State and Federal resource agencies. In addition, this idea was mentioned by many of the investigators in the North Star Research Institute Environmental Impact Assessment Reports. These reports were made available to the general public.

Comment (4,6): Page 135 - In the discussion of migratory fish the disappearance of the skipjack and blue sucker is correlated with the construction of the Keokuk Dam. This dam was constructed 17 years prior to the 9-foot channel project. We believe a more likely correlation would be the construction of the lock and dam system in the 1930's and the disappearance of the skipjack and blue sucker 20 years ago.

Response: It is commonly agreed that the probable cause of the extirpation of the skipjack was due to the construction of dams on the river and/or pollution. The Keokuk Dam was the first of several dams on the Upper Mississippi River. However, the blue sucker has been reported in several locations within the navigation pools of the 9-foot channel project within the St. Paul District and has probably not been extirpated from this area.

Comment (10): Page 135 - It would be worth noting that the elimination of the skipjack was followed by the disappearance of the Niggerhead clam which depended on skipjack for survival.

Response: Concur. The final EIS has been revised, on page 97, to include the information.

Comment (18,11): Page 135, Paragraph One - The "Ohio shad" is now called the "Alabama shad". The correct terminology for the shovelnose sturgeon does not indicate a hyphen in its name. The blue sucker has been taken frequently in the lower Red Cedar River and the lower Chippewa River during the 1968 to 1973 period. This suggests that extirpation north of the Keukok Pool is not likely.

The UMRCC annual report for 1964 reported the blue sucker in pool 5. The Department of Natural Resources has also captured blue suckers in pool 7.

Response: The final EIS has been revised on page 96 to reflect this information.

Comment (4): Pages 135-136 - It is stated that "The commercial fish harvest during post-impoundment times has been mostly greater than prior to the dams. Several species are listed as being important, including carp, buffalo fish, catfish, sheepshead, and suckers. These statements refer only to the quantity of fish taken; the value of the catch should also be mentioned, and these figures might be adjusted to show rising market demand and cost of living.

Response: Concur. Data concerning the above subject from the Upper Mississippi River Comprehensive Basin Study - Appendix L has been included in the final EIS.

Comment (18): Page 136, Sentence One - The source of preimpoundment data which has been used to make the statement that the increased productivity of carp, buffalo fish, catfish, sheephead, and suckers should be included. Any increases in commercial harvest may reflect fishing pressure and improved gear and techniques rather than increased productivity.

Response: The referenced statement has been revised on page 97 of the final EIS. The statement now refers to "commercial fish species" instead of "carp, buffalo fish, catfish and suckers". The source of this data was the Environmental Impact Assessment Reports prepared by North Star Research Institute. These reports were made available to the general public as noted in the Forward section.

Comment (18): Page 136, First Paragraph, Third Sentence - The role of gar and bowfin as a serious predator on game fish is certainly questionable. There is some indication that these predatory species may be beneficial by preventing overpopulation and subsequent stunting of the fishery, particularly panfish.

Response: The final EIS has been revised on page 91 to reflect this information.

Comment (6): The discussion should include effects that continued operation and maintenance have on the low populations of sturgeon.

Response: Although we could not find any documented data on the effects of operation and maintenance on low populations of sturgeon, we feel that such possible impacts would center around the effects of operation and maintenance on the availability of suitable feeding and spawning habitat. In Priegel and Wirth (1971), the Lake Sturgeon, Its History, Ecology and Management, Wisconsin Department of Natural Resources Publication 240-70, it is stated that feeding usually consists of small benthic organisms in water less than 30 feet deep. Priegel and Wirth also state that in the Wolf River, Wisconsin, lake sturgeon prefer to spawn in shallow rocky areas

along the river banks, particularly where the shoreline is reinforced by riprap. It is not known if the habits of lake sturgeon would be the same in the Upper Mississippi River, but if they were, an ample supply of riprap could be found along the edge of the navigation channel.

Comment (6): The filling of some backwater sloughs by sedimentation is cited on page 136 as the reason for oxygen depletion and winterkill. Dredge spoil closures of side channels and shoaling from dredge spoil sites are often responsible for this impact. The final impact statement should identify areas of natural deterioration and areas degraded by spoil deposits.

Response: These areas are identified in Section 3 and 4 of the draft EIS. The spoil sites (1956-1972) are illustrated in Exhibits 32-42 of the draft EIS.

Comment (18): Page 137, First Sentence - We would like to know where the lake sturgeon has increased in numbers on the Mississippi River.

Response: The referenced statement on lake sturgeon was taken from the U.S. Department of the Interior's Resource Publication No. 114 "Threatened Wildlife of the United States", 1973 Edition. The statement is applicable to the entire geographic range of the lake sturgeon and not specifically to the Mississippi River. The final EIS has been revised on page 98 to reflect this information.

Comment (36): With reference to page 137, we regret the absence in the exhibits of most of the data on benthic macroinvertebrates, which we consider to be very important to the *determination* of impacts.

Response: Comment noted.

Comment (6): Current data on mussels should be included in the Aquatic Invertebrate Animals section. Exhibit 95 provides a list of mussels from preimpoundment times but material relative to today is lacking. References to more recent studies and lists are made in the section on Fresh Water Mussels but are not listed or correlated to the list in Exhibit 95. A comparison of mussels present originally and currently would provide a valuable indication of impacts from O&M. Mussels are very sensitive to sudden changes in water quality and sedimentation.

Response: Exhibit 95b, which lists the freshwater mussels collected during the summer of 1973 under the Environmental Impact Assessment contract with North Star Research Institute, has been included in the final EIS. It should be noted however, that the data in Exhibit 95b is not entirely comparable to the data in Exhibit 95a. No attempt was made to depict relative abundance for the 1973 data as such information could not be compared with "Number" in Exhibit 95a. The identification of species was not carried beyond the taxonomic level of Family for pools 7, 8 and 9. This data from pool 9 would have been especially valuable. For further information on this subject, refer to the various assessment reports.

Comment (6): The Waterborne Commerce section is in need of revision and expansion. Comparable data for railroads and other means of transportation should be included. Actual costs of transporting commodities between major population centers would provide more meaningful data than costs per ton-mile.

Response: Inclusion of the suggested additional information would be helpful; however, since the purpose of the referenced section is general in nature it is believed that the information presented is adequate.

Comment (18): Page 138, Paragraph One - It should be clarified that the high number of benthic organisms collected at the mouth of the Kinnikinnick River were not associated with the removal of dredge spoil material. It seems likely that these invertebrate populations were due to some factor other than dredging.

Response: Concur. The sentence beginning with "The most frequent dredging ..." has been deleted from the final EIS.

Comment (18): Page 142, Third Sentence - We would also assume that pools 7, 8 and 9 produce significant numbers of Hexagenia.

Response: Concur. Subject information has been included in the final EIS on page 100.

Comment (10): On page 142, the acknowledgement that the "the constant loss of silted areas due to the encroachment of sand is reducing the populations of burrowing mayflies" should also include a reference citing the heavy dependence of fish on these organisms for food supply. As the mayfly population declines, corresponding declines in fish population can als be expected.

Response: Concur. Subject information has been included in the final EIS on page 101.

Comment (18): Page 143, Second Paragraph - We would question whether amphipods could be described as being "small crayfish-like organisms." They could be better described as "shrimp-like organisms."

Response: Concur. Subject information has been included in the final EIS.

Comment (4): Page 143 - It should be noted whether the tubificids mentioned are the clean or polluted-water forms; if both are present, the relative abundance of each should be noted.

Response: The reference to the term "tubificids" mentioned on page 143 of the draft EIS was pertaining to tube-building forms mostly of the species Tubifex tubifex (the common sludge worm). Since "tubificids" more accurately refers to the family of aquatic earthworms, tubificidae, the term has been changed to "sludge worms" in the final EIS.

Comment (26): On page 143, paragraph 1, mention should be made of the specific location of the study area to indicate its importance.

Response: The particular area chosen for the study had no significance other than it appeared representative of pool 6 in general.

Comment (4): Page 144 - It would be helpful if the more recent studies on mussels referred to in the text could be included. In addition, Exhibit 95 provides a preimpoundment list;however, without a current list, comparison is difficult.

Response: Refer to the earlier Comment/Response concerning Exhibit 95 on page 443.

Comment (10): With reference to page 145, canvasbacks also feed on fingernail clams.

Response: Comment noted.

Comment (18): Page 148, First Paragraph, Last Sentence - This sentence implies that dredging has saved this threatened species of mussels. This is the wrong inference to make, and we would ask what would be done to protect this species during dredging?

Response: Subject sentence has been deleted. Protection of the species during dredging could be accomplished by various means such as filtration screens, restriction of clamshell dredging, retrieval of dredged individuals, etc. However, it may be more important to determine and subsequently eliminate the cause of the population decline if the species is to survive. It is improbable that dredging alone is the primary reason for the decline; other factors such as pollution are undoubtedly also implicated.

Comment (18): Page 148, Paragraph Two - The official list of Wisconsin endangered species included in Chapter 29.415, Wisconsin Statutes, should be mentioned. The new Endangered Species Act of 1973 included in its definition "...any species..throughout all or a significant portion of its range." Therefore, local situations become increasingly important. In this regard, several misleading statements should be clarified, such as on page 152, paragraph one.

Response: The draft EIS considered a larger geographical area than one State. The U.S. Department of the Interior's classifications of "endangered" or "threatened" species were utilized for the purpose of continuity. As was stated in paragraph 2 on page 150 of the draft EIS, animals included on a State's list of endangered species but not included under the U.S. Department of the Interior's classification of "Endangered" or "Threatened" were considered as locally rare. We feel that this method of classification is consistent with Public Law 93-205, the Endangered Species Act of 1973.

Comment (18): Page 150, Paragraph Two - "locally rare" is an artifical term not used in any Federal or State terminology. New uses of old terms should not be introduced into an already cluttered literature. Wisconsin has an official list of endangered animals, and a supplementary list of rare or declining animals called "changing status".

Canada lynx, northern bald eagle, osprey and cormorant are found in the Mississippi River as well as elsewhere in the State of Wisconsin. They are endangered in this State although not nationally. These animals are not "locally rare". In addition, many of the species listed in Exhibit 98 are on Wisconsin's changing status list.

Response: Comment noted.

Comment (11): Page 150, Lines 13-14 - The timber wolf would not be found naturally in the study area, not "probably not" as the report states.

Response: Comment noted. However, as long as a remote possibility exists, it is believed that "probably not" remains appropriate.

Comment (11,18): Page 151, Lines 6-8 - According to our records, the northern greater prairie chicken is no longer present, not "quite rare" in the study area.

Response: Concur. Indicated sentence has been altered from "quite rare in" to "absent from", on page 105 of the final EIS.

Comment (18): Page 152, Second Paragraph - We doubt whether the 9-foot channel navigation project has had anything to do with the concentration of eagles at the mouth of the Chippewa River. We would suspect that this area had open water even prior to the establishment of the locks and dams. There is no evidence to suggest that the shortage of winter feeding areas has limited the population of eagles. It is more probable that pesticides and disturbance by man has had a greater effect on the limited populations of bald eagles. Some mention should be made of the congregation of eagles at Genoa during the winter time.

Response: Concur. The sentence "Two valuable feeding areas for bald eagles have apparently developed as a result of the 9-foot navigation project" has been changed to "Two particularly valuable feeding areas for bald eagles exist within the navigation pools of the St. Paul District," on page 106 of the final EIS. The sentence referred to in the second half of the comment has been deleted.

Comment (28): On page 152, paragraph 3, it is stated that "Two valuable feeding areas have apparently developed as a result of the construction of the 9-foot navigation project." There is no data in the Environmental Impact Statement to support this comment. Given the rate of flow of the Chippewa River combined with the subsequent outflow of Lake Pepin

at the same location, there is reason to believe that an "open water" condition could exist anyway in early winter, providing a natural feeding area. In terms of feeding on wounded waterfowl, at Weaver, this condition could well exist in spite of the project, but there is no doubt that the project has created a larger hunting area and thus created a more viable feeding area.

Response: Concur. Reference is directed to the previous Comment/Response.

Comment (18): Page 152, Third Paragraph, First and Second Sentences - Since the double-crested cormorant is listed as an endangered species in the State of Wisconsin, we request that the location of nest sites be indicated in the draft Environmental Impact Statement. We also feel that the effect of the operation and maintenance of the 9-foot navigation project should be evaluated with respect to the continued perpetuation of the species.

Response: No known nesting sites presently occur within the navigation pools addressed by the statement. Occasional sightings of cormorants are believed to be either migrants or non-breeding individuals.

Comment (18): Page 153, Third Paragraph - It should be pointed out that the species of plants which are legally protected under Section 29.546 of the Wisconsin Statutes includes American lotus, trailing arbutus (Epigaea repens), ladyslipper orchid (Cypripedium), members of the orchid family (Orchidaceae), trillium (Liliaceae), American bittersweet, pitcher-plants, (Turks caps), and wood lilies. American lotus occurs in large beds in portions of the Mississippi River backwater areas. Operation and maintenance of the 9-foot channel could adversely affect this species.

Response: Subject information has been included on page 107 of the final EIS.

Comment (18): Exhibit 99, Page 118 - Aplectrum hyemale is known as the adam-and-eve or the putty root.

Response: Comment noted.

Comment (11,18): Page 154, Lines 7-8 - The lotus is common in many of the pools, not "uncertain in distribution" as the report states.

Response: Concur. Subject information has been included in the final EIS.

Comment (18): Page 157, Second Paragraph, Last Sentence - Since water-oriented recreation is an economically important asset to this portion of the upper midwest, we request that the economic value of this industry be indicated.

Response: The use of an economic value of the outdoor recreation in the context presented would require applying the same treatment to the other industries listed, such as forestry and dairying. A detailed economic analysis at this location would be out of context. Furthermore, economic data are presented in other sections, such as the pool-by-pool treatment.

Comment (26): Page 158 - "Proceeded" should probably be "preceded".

Response: Correction has been made in the final EIS.

Comment (6): The entire section of the 9-foot channel controversy further illustrates inclusion of unnecessary material. A short review of the topic in the historical section is warranted, but the discussion as written is so long and involved that it detracts from the statement. The lengthy letters from various commercial interests included as support for the 9-foot channel add little factual value to the statement.

Response: Comment noted.

Comment (18): Page 159 - Contrasting the upper picture with the lower picture, it is interesting to note that several acres of wetland areas were inundated by the construction of lock and dam No. 4.

Response: Concur.

Comment (18): Page 160, First Paragraph, First and Second Sentences - While the 9-foot navigation project may have been important to the national defense of the Nation in the 1930's, it is doubtful that in this day and age it would be of significant strategic value. Since this portion of the Mississippi River has a 9-foot channel, it would be questionable whether any large naval vessels could even navigate the Mississippi River. The possibility of nuclear warfare, combined with the advent of long-range aircraft and intercontinental ballistic missiles, puts the Mississippi River and it's locks and dams within easy striking distance of any hostile nation with conventional armaments.

Response: Comment noted. However, the important value presented was as a water transportation route for food, arms and other supplies, rather than for movement of naval vessels.

Comment (18): Page 161, Last Paragraph, and Page 162, First Paragraph - While the veracity of these statements may have been questioned at the time of authorization of the 9-foot channel project, the Mississippi River is beginning to resemble the state indicated by many of these predictions. Erosion has resulted in a considerable amount of sedimentation and movement of bedload in the Mississippi River. Pollution, particularly in the upper pools, has adversely affected water quality and the fisheries. It is also true that the operation and maintenance of the 9-foot channel has had an adverse impact on the smallmouth bass fishery, and that it has cost a considerable amount of money to dispose of the dredge spoil materials.

Response: Comment noted.

AD-A133 511 OPERATION AND MAINTENANCE 9-FOOT NAVIGATION CHANNEL UPPER MISSISSIPPI RIV..(U) CORPS OF ENGINEERS ST PAUL MN ST PAUL DISTRICT AUG 74 6/8

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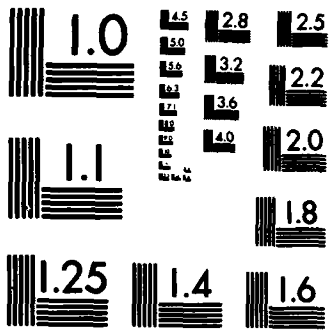

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Comment (18): Page 162, Second Paragraph, Second Sentence - The prediction that the pools would fill with sand within a period of 20 years was perhaps shortsighted; however, it is known that the backwater areas are gradually filling with sediments.

Response: Comment noted.

Comment (18): Page 163, Last Paragraph, Last Sentence - The statement that a spectacular increase in barge traffic and tonnage is evidence of the economic success of the project is not adequate proof that the project is desirable. At this point in time, part of the economic success of the project is dependent upon the continued disposal of dredge spoil materials at a cost of 33 cents per cubic yard. This has resulted in environmental losses. It has not been shown that the operation and maintenance of the 9-foot channel project is an economic success to the taxpayer or if it is solely an economic success to the barge interests. In order to determine the economic success of the project, it would be necessary to know the cost of operation and maintenance of the 9-foot channel and also the environmental costs which are connected with the project.

Response: The referenced statement has been modified on page 114 of the final EIS. This statement does not mean to imply that the project is desirable, but rather refers to the "economic" aspects of the project. Although the current relatively low cost of channel maintenance dredging helps to reduce the total economic costs of the project, no indication is given as to how much the economic success of the project depends on the cost of operation and maintenance activities. The O&M activities of the 9-foot channel are the subject of this impact statement, the division of project related benefits has not been determined for the EIS. Justification of the original project is not the issue under discussion. To determine the complete economic impact of the project, information in addition to O&M activities and environmental costs would be needed.

Comment (18): Page 164, First Paragraph, First Sentence - As stated previously, it is felt that the treatment of the effect of the original project on the natural environment was minimal, and that this point needs additional detailed analysis and consideration.

Response: Refer to the previous Comment/Response.

Comment (6): Prior to final determination of spoil deposition areas, the appropriate State Archaeologist should be consulted for information regarding known archaeological values that may be affected. In addition, we suggest that all areas eventually designated for spoil deposition be examined systematically by a professional archaeologist to locate presently unrecorded archaeological remains. If, through these means, it is determined that archaeological remains will be affected by spoil piling, selection of alternatives should be considered. If it is not

Possible to select an alternative to avoid impact, the endangered resources should be fully assessed.

Archaeological remains constitute a cultural resource that is fragile and nonrenewable; accordingly, every effort must be made to fully evaluate and record the nature of such resources before a decision is made to adversely affect them through the implementation of any current or proposed action. Burial of such remains, fully assessed and documented, below spoil piles would not preclude necessarily future investigation of these resources. However, surface sites, and those near the water line, are subject to partial or total loss through the hydraulic action of spoil placement by dredge means. We must emphasize that a determination to pile dredge spoil on archaeological resources must be made only in close consultation with appropriate archaeological interests. Such consultation may reveal the feasibility of conducting salvage excavations of endangered resources prior to initiation of deposition activities.

Response: Since most of the spoil deposition since impoundment has been located along the navigation channel it is doubtful that there has been any more adverse impact than what occurred at the time of the impoundment. Plans are being made to contact each state preservation officer, including state historical societies to advise them of the proposed spoil disposal site and request recommendations regarding the need for investigative work. It is expected that this coordination will take place as soon as the Corps' and the various environmental agencies agree upon feasible off-channel disposal sites. In accordance with the requirements of Section 106 of the National Historic Preservation Act of the 1966 and Executive Order 11593 it is the intent of the Corps to recognize the need for identifying and assessing the particular resource.

Comment (14): The report does not begin to reflect or suggest the importance of the floodplains to man during the past 11,000 years, nor does it suggest that the diversity of food resources and raw materials available figured importantly in prehistoric settlement patterns and subsistence systems. Neither does it suggest that the encampments and village sites reflecting seasonal procurement schedules exist (or existed) along the sloughs, ponds and streams which are present.

We may, on the basis of our limited understanding of prehistoric settlement patterns, suggest that all of the ponds, sloughs, islands and tributary streams have evidence of this prehistoric occupation along their banks. Similarly, the dependence of early Euro-American settlers upon the same national resources permits us to assume the liklihood of the presence of historic sites in the same areas.

Because the operation and management of the 9-foot channel poses a direct threat to those historic and archaeological sites which survived the

initial construction of the locks, dams, and attendant pools, I should like to make the following points.

1. The draft EIS does not discuss the need for a survey which would locate and identify archaeological or historical sites or historical objects, such as sunken riverboats, prior to any dredging operations.

2. The draft EIS does not discuss or intimate the need for the scientific recovery of data and/or artifacts from historic or archaeological sites located by such a survey prior to authorization of a dredging project.

3. The Corps of Engineers, as directed by Executive Order 11593, has the clear responsibility to survey property under its jurisdiction and control to determine the presence of historical and archaeological resources, and to nominate to the National Register those which meet the criteria.

Response: Those archeological sites that were covered by the impoundment creating the Mississippi River pools are lost and almost impossible to investigate or recover. Since maintenance of the 9-foot channel was begun practically all dredging occurred in the navigation channel and the deposiion placed adjacent to the channel. Thus, it is doubtful if there has been much adverse impact. After the Corps' and environmental interests agree on alternatives for off-channel dredge disposal, particularly along the shore, arrangements will be made with state historic preservation offices and state historical societies to make investigations of proposed areas and where necessary make recommendations for alternate disposal sites.

Comment (14): The final Environmental Impact Statement must address itself to the fact that the number and distribution of archaeological and historical resources is not known because there has never been an adequate survey. It should note that the Corps has the responsibility to insure that such surveys are conducted and discuss the methods to be employed.

The State Historic Preservation Officer for Iowa will make every attempt to establish and maintain close liaison with the St. Paul District in order to provide for and coordinate such surveys along the Iowa border. It is suggested that prior to the authorization of any dredging operations which will result in the deposition of spoil upon islands or floodplains the St. Paul District might:

1. Identify the dredging and spoil deposition areas for the State Historic Preservation Officer.

2. Through coordination with the State Historic Preservation Officer, cause a survey of the area to be conducted by qualified individuals.

3. Report the results of the survey to the State Historic Preservation Officer.

4. If the survey identifies historic or prehistoric sites or objects which would appear likely to be adversely effected, take steps to implement Section 106 of the National Historic Preservation Act of 1966, and to

determine potential National Register significance in compliance with Executive Order 11593.

Response: It is planned to contact each state historical office of the States along the Mississippi River within the St. Paul District to determine which of those known archeological sites have been affected by the formulation of the 9-foot channel. Recommendations will be requested regarding the type of action to be taken by the Corps. If additional investigations are recommended, efforts will be made to finish the work on a priority basis. As alternatives for spoil disposal sites are selected, plans for additional investigation will be made. If the investigation results in recommending a survey, another disposal site will be selected or the necessary action initiated to assure that a survey will be made.

Comment (15): Early surveys for archeological sites concentrated on the bluff line areas which will not be affected by the raising of the channel or spoil deposits. However, the report makes no mention of the possibility of sites in the floodplain itself. The work being undertaken at Luther College would strongly suggest that prehistoric peoples for some time were engaged in a process of Intensive Harvest Collecting (Struever 1968) in the floodplain area. The reason we have no evidence for this process is simply that no surveys have been conducted in the floodplain. It should seem apparent to these investigators that if numerous mound groups are located along the bluffs it is only logical to assume that the people were systematically exploiting the diverse and abundant natural resources in the Mississippi trench.

Response: Comment noted.

Comment (10): The zone of influence of the river on page 169 is understated. 1967-68 Sport Fishery Surveys of the Upper Mississippi River Conservation Committee show, for example, that nearly one-fourth of the anglers interviewed in pool 7 traveled over 150 miles. A significant number travel for river trips of considerably more than one day for such unique experiences as river recreation by rented houseboat.

Response: The designation of a "primary zone" is standard procedure for estimating potential recreational use of an area. No attempt was deliberately made to understate the recreational use of the Upper Mississippi River.

Comment (10): Page 170 - Exhibit 103 used the same projected 2020 population figure for both Hastings and Hudson. Hudson should be much less than stated.

Response: Correction has been included in the subject exhibit.

Comment (6): Section 1(2) and 1(3) of the Executive Order 11593 deal with the necessity that your activities contribute to the preservation of cultural resources in both Federal and private ownership. Sections 2(a) and 2(b) of the same order deal with the identification, evaluation and nomination of cultural resource properties, and place the identification responsibilities on the Federal Agencies.

Your statement that plans to inventory the archeological sites was abandoned, for whatever reason, is not in compliance with either the letter or spirit of Executive Order 11593. On properties owned by the Corps, the Executive Order required that an indentification of all properties meeting the criteria for nomination to the National Register be completed and nomination forms executed on all such properties by 7/1/73. On sites not on Federal land, but which are affected by Federal license, funding or programs, the Executive Order requires the agency to contribute to the preservation of those sites. The latter requirement, like the former, requires a knowledge of what the resources are. If the resource base is not known or is incompletely known, then it would be necessary for the agency to identify it.

Response: Inventories of sites for archeological or historical significance has in the past been prompted by initiation of construction plans and/or a designation that a site along the navigation channel would be utilized for dredged material deposition. Evaluations are normally conducted by State and University personnel associated with specific aspects of the project as well as historical - archeological concerns. At the present time no known sites on Corps land are considered by States bordering the Upper Mississippi River navigational pools as worthy of nomination to the National Register.

Comment (6): Your listing of an interdisciplinary team does not indicate the participation of archeologists. This area of Upper Mississippi River is a highly sensitive area containing evidence of poorly understood aboriginal cultural interchange. The cultural resource base found in this area must be fully considered, and management decisions must be based on a professional evaluation of the importance of any given area, not only with regard to the natural environment, but also with regard to cultural environment. Particularly sensitive in this respect is the area in the vicinity of pool 10. Effigy Mounds National Monument is on the National Register of Historic Places. In order to have an adequate statement you need to indicate what, if any, effect you will have on this property. I did not find such a statement. You will also need to make a determination of adverse or no adverse effect under the procedures of the Advisory Council, and, if there is to be an adverse effect, give them the opportunity to comment.

Response: Archeological impact was provided principally in formulation of the Environmental Assessment Reports for each navigation pool and its omission from the interdisciplinary research team was an oversight.

Recognition of subject discipline has been included in the final EIS.

It is stated on page 229, Section 4, that operation and maintenance of the 9-foot navigation channel has not affected Effigy Mounds National Monument. It is believed that no future activity will affect the site as it is in excess of 1 mile from the navigation channel.

Comment (6): The National Environmental Policy Act requires that you take cultural resources (among others) into consideration at the earliest possible stage of planning. You must know what the resources are in order to give them proper consideration in planning. In addition to checking the National Register for any sites that might be listed, you should check with the State Historical Preservation Officers of each of the States involved in the area of consideration regarding sites that they are considering.

Response: Concur. It is believed that adequate reference is contained throughout the statement in regards to natural resources and their relationship to the 9-foot channel project. State Historical Preservation Officers have been contacted and subject correspondence is located in Exhibits 232 to 236 and Exhibits 249 through 252 in the final EIS.

Comment (6): In addition to the great amount of archeological sites (estimates of qualified sites number into the thousands), this area is also important in the early history of the Midwest, the fur trade, river trade, and westward expansion themes. In any area along a major riverway -- particularly one which is not completely studied -- there is high potential for finding significant cultural resources. In this project area it would appear that you need to be particularly concerned with sites that would probably occur in the following proveniences:

1. sites, such as shipwrecks, which have river bottom proveniences which might be destroyed or damaged in dredging operations.

2. sites along the banks of the river or on islands in the river which could be destroyed or damaged in channel modifications, levee construction, clearing and snagging activities and dredge spoilage disposal.

3. sites along river banks or on islands which might be affected by increased erosion as a result of faster moving water or changes in channel location.

Regardless of the considerations that are listed on page 165 of your statement, you cannot comply with the mandates of the legislation and Executive Order unless you cause a professional evaluation of the resources to be made. Such evaluation will of necessity have to be more than a literature search. It will be necessary for your agency, as the one responsible, to assure that your activities will not adversely affect the resource.

If you are unable to obtain the information from readily available sources, then it will be incumbent upon you to obtain the information through contract or other procedures.

Response. Concur. An evaluation to determine the subject resource inventory is currently under consideration by the Corps and will be implemented as soon as possible.

Comment (3): Exhibit 103 - Population data figures should be rounded off to nearest 000.

Response: It is believed that the projected figures are usually considered estimates and that rounding off to the nearest 000 would not add substantially to the value of the data.

Comment (10): Page 171 - Pierce County actually has much less land area of 12% or greater slope than downstream counties. Picture outline should cite need for good soil conservation practices to control soil losses in all river counties covered by the statement.

Response: Comment noted. Advocation of good soil conservation is frequently noted in the text of the statement.

Comment (10): Page 172 - Statement of causes of land erosion is strong supporting evidence of need for erosion and sedimentation control in uplands to avoid compounding Mississippi River management and ecological problems. The statement is generally deficient in clearly describing the total picture of lands and water acreages; a better breakdown is needed of total project acreages as to all water, all lands, public lands, private lands, Corps-administered water and lands, Bureau of Sport Fisheries and Wildlife-administered waters and lands, etc.

Response: We agree with the first half of the comment. A contract active at this time is generating, via the interpretation of various types of remote sensing imagery, data pertaining to the acreages of various habitat types, spoil deposits, etc. Baseline maps will be developed which delineate these acreages in 1973 and 1939. This information will be made available as soon as it is received.

Comment (3): Page 172 - It is suggested that the sentences "Even today, the watershed is severely abused by agricultural practices" and "Step slopes, in most areas, are still plowed and grazed", be deleted. They do not add significantly to the already adequate discussion of agricultural land use.

Response: Comment noted.

Comment (26): Correct the name of the refuge on page 173, paragraph 1.

Response: The refuge name has been corrected.

Comment (10); Page 173 - Attractiveness of the refuge for such non-consumptive uses as birdwatching, wildlife photography, etc. should be added.

Interstate and William O'Brien parks in Minnesota, and Interstate park in Wisconsin are not on the 9-foot channel project. No attendance figures are given to indicate importance of the recreational use of the river-oriented parks, even though the Corps' 1955 Master Recreation Plan for the 9-foot channel project (which was obviously used as a basis for this section) contained figures on park visitation Facilities are available for water-based recreation at O'Brien and the Interstates (which are not on the 9-foot channel) and at Fort Snelling parks. However, all attendance figures and facility descriptions should appear in the recreation discussion, pp. 179-186.

Response: When the Mississippi River master plan is updated it is possible that recognition may be given to non-Federal recreation areas and facilities, but since the impact statement is concerned primarily with the 9-foot channel corridor there appears to be no need to expand the current consideration beyond the corridor.

Comment (41): Page 173 - There is a southern extension of Effigy Mounds Monument at Sny Macgill Creek. At present it is not developed but there is river access at this site through the Sny Macgill landing operated by the Iowa Conservation Department.

Response: Subject information has been included on page 121 of the final EIS.

Comment (18): Page 174 - First Paragraph, First Sentence - It should also be noted that an additional Wisconsin State park has been established at the mouth of the Kinnikinnick River. This new park, located in Pierce County, is called the Kinnikinnick River State Park. The Kinnikinnick River delta at the mouth of the Kinnikinnick River is also a dredge spoil disposal site.

Response: Subject information has been included on page 121 of the final EIS.

Comment (18): Page 174, Third Paragraph, First Sentence - The statement that "Since 1940 when the 9-foot channel had been placed in operation, river traffic increased rapidly" cannot be made since the tonnage figures in the table at the bottom of page 174 ends at the year 1945. Thus, nearly 30 years of data have not been placed in this table for consideration.

Response: Information as presented in the draft EIS in Exhibits 104 and 105, and in the remaining portion of the text support the initial statement. The table referenced at the bottom of page 174 of the draft EIS was included for the reader's information and provides information which is not contained in other locations in the text.

Comment (10): Page 174 - Since pre-1940 references to tonnage of waterborne commerce are out of context, both with the 9-foot channel project and with the St. Paul District boundaries, they should not be used. For the sake of simple comparison and continuity, tonnage figures for those years shown on graphs Exhibits 104 and 105 should be sufficient to make the point.

Response: Inclusion of pre-1940 data was presented to illustrate both a post- and pre-project comparison and a historical overview of trends.

Comment (10): Pages 174-178 - The purpose of the 9-foot navigation channel project is to provide a means of transporting certain types of commodities and products in interstate commerce. At several points in the statement, the Corps estimates that this waterway project saves between 4.0 and 5.4 mills per ton-mile in shipping costs over the other various least-cost alternatives. However, the draft report virtually ignores the existing alternative transportation systems parelleling and crossing the 9-foot channel. Such a discussion should certainly be a part of the description of the Environmental Setting in the final EIS. For example, for much of its length, the 9-foot channel in the St. Paul District has high-speed, double-track rail lines on both sides of the river. Modern Interstate, Federal and State highways parallel or cross the river throughout the project, as do interstate petroleum pipelines. Although they are not likely to provide means to handle the kinds of freight now shipped by water, the several airports providing scheduled airline service to the valley should be described since they do serve as a means for people to reach the area for other river uses.

Response: A statement on the referenced topic has been added to the final EIS on page 124.

Comment (18): Page 175, Second Paragraph, Second Sentence - This is not to say that should the barge traffic on the 9-foot channel be eliminated, the economy would collapse. It would appear that alternate transportation modes could be developed which would not be so heavily dependent upon governmental assistance.

Response: Page 175 of the draft EIS emphasizes the importance of the waterway. One could make a similar statement about rail or truck, etc. Governmental dependency is not germane to the purpose of this section of the EIS.

Comment (10): Page 175 - "Other Freight" represented about one-third of the receipts in the District in 1970, according to the graph in Exhibit 104. Such a large portion of the total traffic should be identified by commodity. Also, assuming that a significant amount of "other freight" is comprised of sand and gravel, how much, if any, is used to maintain the 9-foot navigation channel?

Response: In 1970, sand and gravel receipts represented about 57 percent of the other freight receipts in the St. Paul District. About 54 other commodities comprise the remainder of the other freight category. Thus, in 1970, sand and gravel receipts represented about 19 percent of total receipts in the District. The information presented in Exhibit 104 is to give the reader a general indication of the type and amount of commodities received in the St. Paul District. More information is available in the St. Paul District office. The sand and gravel listed in the other freight category is not used to maintain the 9-foot navigation channel. An insignificant amount of sand and gravel is used with riprap on structures.

Comment (18): Page 175, Third Paragraph, Last Sentence - This sentence sounds as though competing forms of transportation should not be encouraged, and that they in fact are occasionally more economically feasible than barge traffic on the Mississippi River.

Response: The sentence does not lead to this conclusion. It simply states the various reasons for fluctuations in shipments.

Comment (18): Page 176, First Paragraph - It is requested that similar data be prepared for transportation by railroads in order that the data shown in the table at the top of page 176 could be compared to the amount of shipments made by barge traffic.

Response: Inclusion of the suggested additional information would be of value, but since the purpose of the referenced section is general in nature it is believed that the information presented is adequate.

Comment (18): Page 177, Second Paragraph - It should be clarified that part of the reason that the 9-foot channel project has resulted in a savings in transportation costs for bulk commodities is due to laws against railroads with regard to large bulk shipments. In order to state that the shipment of cargo by water is more economical than

the next least cost alternative, data should be provided to substantiate the calculations of this apparent economic benefit. It is entirely possible that if the total environmental costs of the present system of dredge spoil disposal were taken into account, that maintenance of the 9-foot channel would become sufficiently expensive to render water transportation less economically advantageous. If the environmental costs involved with present dredge spoil disposal practices and costs for operation and maintenance of the 9-foot channel project were added to unit costs for barge traffic, the savings over other least cost alternatives would be less than 4 to 5.4 mills per ton mile.

Response: The source of information regarding the cost savings are referenced in the final EIS. Substantiation of the reasons for the cost savings are not felt to be necessary for inclusion in the EIS, since the source of information is referenced. The regulations which govern the operation of the railroads is not felt to be of primary importance to the topic of the EIS and as such is not discussed in the final EIS. To be comparable, added costs due to environmental reasons must be considered on all alternative modes of transportation. Currently, such comparisons are not available.

Comments (40): The rate saving value of 5.4 mills per ton-mile is incorrect. For the five commodity groups where the railroads are the primary alternative mode of transportation, the average rate savings is only about 3.8 mills per ton-mile. Waterway shippers in shipping by barge rather than by rail should automatically save about 4 mills per ton-mile merely by not having to contribute (through rail freight rate charges) to the railroad right-of-way costs and taxes.

Response: Comment noted. However, the information regarding the 4.0 to 5.4 mills per ton-mile cost savings is presented as a general indication of the economic benefits related to continuing the operation and maintenance of the 9-foot channel navigation project. Specific information on these cost-savings with respect to each alternative mode of transportation related to the continued operation and maintenance of the 9-foot channel project within the St. Paul District are not readily available. The information presented in the draft EIS is considered adequate for the purpose intended.

Comment (10): Page 177 - By inferring that "farms, factories, storage facilities, and refineries" are dependent on river shipping, the statement suggests that such entities would not succeed without commercial river navigation (and future O & M). This is an unsound argument since it presumes that, given equivalent public policy objectives and funding, other means of transport would not be economically feasible. There is no foundation for such a supposition. They are only partially dependent on the 9-foot channel and would not necessarily go out of business if the channel system was phased out sometime in the future for some reason.

Response: The referenced statement has been revised in the final EIS on page 123.

Comment (4): Page 178 - The limited amount of data presented in this section makes it difficult to examine the conclusions. In actuality, the only information supported by data is the fact that the majority of fish are produced in pools 4, 8, 9, and 10. This section should include data on the preproject conditions compared with present production, including data on overall trends in the catch, change in species composition, changes in fish movement or concentration that resulted from project maintenance and the effect of market changes, and improvements in fishing methods and gear.

Response: The Commercial Fishing and Trapping subsection has been revised in the final EIS.

Comment (6): The limited commercial fishing data used in this section (page 178) and the inferences drawn from this data are questionable. Using only 1960 and 1969 data, when considerable information was available, does not adequately portray the commercial fishing situation. Available data from the late 1800s to 1972 should be included in the statement. The contention that commercial fishing improved with installation of the 9-foot channel project should be supported by data. Certainly, Exhibit 107 does not contain the necessary information to substantiate the claim of a 9 percent increase in harvest. By using the data presented for 1969 and more recent data, one also can show that production has decreased 29 percent since 1969 (based on 3.9 million pounds of fish caught in 1972). The indication that pools 4, 8, 9, and 10 produce the most fish is the only valid information given. Overall trends in the catch and, of particular importance, the change in species composition of the catch should be explored; and a detailed discussion on changes in fish movements or concentrations that result from the O&M activities, particularly dredging is needed. Also, an analysis of changes in commercial catch resulting from market changes and improved fishing equipment and techniques would add considerable to this section on commercial fishing.

Response: The subsection on commercial fishing has been revised in the final EIS. Five tables have been added to Exhibit 107 to more clearly indicate the significance of commercial fishing on the Upper Mississippi River.

Comment (6): Trends in the fur harvest and the impacts of the O&M activities on the fur harvest must be discussed if the statement is to be complete. We believe, too, that fluctuations in the harvest that result from changes in demand for furs would be a factor in the analysis. Incidentally, the value of furs from the Upper Mississippi River Wild Life and Fish Refuge is expected to top $500,000 for 1973-1974.

Response: A discussion relating to fur harvest is located in the Environmental Setting section page 129. A thorough analysis separating price fluctuations versus habitat changes in regards to fur harvest was impossible during the recently completed studies. However, it is hoped that a thorough evaluation can be made prior to the requirement for updating the statement. The project fur price figures for 1973-1974 have been included in the final EIS.

Comment (18): Page 178, First Paragraph, Last Sentence - The statement "Dredging and the movement of tugs and barges does increase water turbidity to which must be added pollution from barge spillage and cleaning. Yet this pollution is small relative to the pollution load placed in a river from other sources" cannot be made unless a comparison is made to other sources of pollution. This Department has had experience with oil spills from barges. In examining the materials often times transported by barge, it is found that cargoes such as fuel oil and ammonia are potentially hazardous.

Response: It is believed reasonable to refer to a relative undocumented comparison in this instance because of the lack of data on types and quantities of pollutants normally drained into the river. Pollutants as a result of urbanization, industrialization, and agricultural practices are generally considered to be of a much greater quantity than those related to dredging, tugs, and barges. Subject paragraph has been modified, however, on page 124 of the final EIS.

Comment (39): Page 178 notes "pollution from barge spillage and cleaning" as problems. Barge cleaning is performed at plants licensed by the Minnesota Pollution Control Agency and they permit no pollution of the river.

Response: Comment noted.

Comment (6): Contrary to the last paragraph in this section, pollution from dredging, spoiling, lock and dam maintenance, large boats and tows, bilge draining, and barge cleaning is significant. Although there may be

larger sources of pollution on the river, O&M pollution stemming from O&M sources is an issue of major concern, and should be addressed in the statement.

Response: Subject paragraph has been modified on page 124 of the final EIS.

Comment (10): Page 178 - The last paragraph on Waterborne Commerce should be rewritten to clarify the meaning of the first sentence, and to quantify the amount of water quality degradation associated with commercial navigation and O&M relative to other pollution sources.

Response: The referenced paragraph has been revised on page 124 of the final EIS.

Comment (10, 18): Pages 178-179 - Section on Commercial Fishing and Trapping should be rewritten to more fully represent the significance of the socio-economic impact of this use. As written, it is incomplete and outdated. It fails to consider employment, meaningful value and amount of fish and animals taken over a reasonable period of time (such as latest ten-year averages) and primary species of fish involved, i.e., carp, buffalo, catfish and freshwater drum. Today's values for beaver and muskrat furs are about twice that represented. Mink and raccoon are not mentioned. Appendix L of Upper Mississippi River Comprehensive Basin Study on Fish and Wildlife has good source material. The 1970-71 value data cited on page 168 of the pool 5 volume of the Final Environmental Assessment is also more up-to-date than the data used in the draft EIS.

Response: The Commercial Fishing and Trapping subsection has been revised in the final EIS. The above-mentioned sources of information were given full consideration during the revision process.

Comment (18): Page 179, First Paragraph, Last Sentence - An average value of $100,000 annually for raw fur prices would amount to a value of $3,000,000 in the 30-year period. The value of fur should be followed from the price paid to the trapper to the finished fur on the retail market and all the steps in between in order to get a total economic value.

Response: Comment noted. However, it is not believed that relating additional costs of fur prices through the retail market would add significantly to the quality of the final EIS.

Comment (10); Page 179 - A summary statement and data on the 1969 forest management plan for the Upper Mississippi River Wildlife and Fish Refuge should be included in the final EIS, with figures showing estimated acreages, board feet and cords. Such information was available in the Environmental Assessment, but deserves reference in the EIS.

Response: Information for the 1969 Forest Management Plan of the Winona District (pools 4, south of the Chippewa River, 5, 5A, and 6), Upper Mississippi River Wildlife and Fish Refuge is included in the final EIS on page 130.

Comment (11): Page 179 - Since it is difficult to determine the exact influence that each of many factors have had in increasing the recreational use of the river, it only can be assumed that "a significant portion of today's recreational activity on the Upper Mississippi River is due to the improved navigation opportunities for large pleasure craft, and to improved fish and game habitat resulting from higher water levels created by the locks and dams". Much more factual data and explanation is needed to back up this claim before it can stand as an unqualified statement.

Response: The phrase means that with construction of the locks and dams for navigation in the 1940s the resultant increased water-based recreational resources have satisfied a significant recreational demand. Without the locks and dams it would appear that many of the recreational activities enjoyed today would be of a lesser nature. It would be impossible to ascertain what the difference in recreational participation might be if there were no locks and dams. But one can be assured that whatever the value would be, it would be significantly lower than it is under present conditions. For example, compare the recreational use above the head of navigation on the Mississippi River, excluding lakes to that of the navigable portion. Further quantification of comparable recreational data is not possible at this time. More definitive data will be included in an updated statement.

Comment (18): Page 180, Second Paragraph, First Sentence - This statement cannot be made until the adverse impacts attributed to the presence of the project are completely described in order to determine the changes in fish and wildlife habitat and recreational opportunities.

Our opinion is in conformity with the previous statement which states, "Segregating present day recreational uses of the study area from those existing in 1930, prior to the 9-foot channel, presents problems. It is difficult to isolate increased recreational uses of the river caused by more people in the region, changed standards of living, and increased leisure, from those caused by improved navigational and other recreational opportunities."

Response: Refer to the previous Comment/Response.

Comment (6): On page 180, second paragraph, the phrase "significant portion of today's recreational activity. . ." needs to be quantified. Recreation activities have increased and are projected to increase at an even greater rate, but the exact influences that O&M functions have had on recreation is not addressed.

Response: Refer to previous Comment/Response.

Comment (10): Page 180 - Fishing and hunting are discussed here as though they are classified as a part of present-day recreational activity. While they really should be so considered, the BOR tabulations do not include them. The final EIS should acknowledge this distinction. Also, more recent data on demand for outdoor recreation in the basin should be used.

Response: Fishing and hunting are part of the present-day recreational activities and are recognized by the Bureau of Outdoor Recreation. More recent demand data relative to the 9-foot channel corridor is not available. However, recreational use studies are being conducted in several Mississippi River pools which should provide a very good indication of the breakdown in types of use. Unless recreation use studies are made consistently and regularly, the end results can often be misleading.

Comment (10): Page 180 - A general comment on the unrealized potential for hunting and fishing due to effects of both the 9-foot channel project and industrialization (as in paragraph 2 on p. 223) should be included in the District-wide discussion of the subject. It should be acknowledged that Exhibit 108 does not include fishing and hunting.

Response: Subject material included on page 131 of the final EIS. Subject acknowledgment included on page 132 of the final EIS.

Comment (6): Projected recreation use data provided are based on 1960 census data and are not valid today. More recent data on recreation needs would be desirable for discussion in this section. This data should be available from the State Comprehensive Outdoor Recreation Plans.

Response: We agree that more recent data should be used. However, State recreation plans relate to regions which more often than not include areas outside the zone of influence associated with the river corridor. Thus, when the current recreation use studies now in progress on the Mississippi River are completed, more realistic and accurate information will be available and can be incorporated in an updated statement.

Comment (11): Page 181 - The source for the statistics on projected outdoor recreation demand for the study area as shown on the table on page 181 and in Exhibit 108 should be cited.

Response: Information contained in Exhibit 108 was derived from Appendix K, page 55, of the Upper Mississippi River Comprehensive Basin Study. No explanation is provided in the study regarding the origin of the data utilized.

Comment (11): Page 181 - Last paragraph, first sentence - The report should be more specific when citing sources of information. The 1964 inventory by the Bureau of Outdoor Recreation was not the most recent nor most complete. Both the States of Minnesota and Wisconsin have more recent data available in their respective Outdoor Recreation Plans and this should be investigated.

Response: The 1964 report is the latest in which all Federal and non-Federal recreation lands and waters have been mentioned. Thus, the information should be used as indicated until a more recent study is conducted.

Comment (41): Page 181 - As a result of the current shortage of fossil fuel an increased utilization of nearby recreation areas is to be expected. The proximity of the Upper Mississippi River to both Minneapolis-St. Paul, and Chicago, will probably result in increases in water related activities well in excess of the five fold increases predicted from the 1960 census values.

Response: The five-fold increase was determined some time ago when an energy crisis or shortage was not a factor considered. Assuming that there is an energy shortage this estimate could be exceedingly optimistic. At this time there appears to be no reason for revising the prediction or estimate.

Comment (10): Page 182 - The sentence, "The study area contains about 70 percent of the inventoried acreage," should be clarified to define the "study area" involved. (Surely the 9-foot channel project in the St. Paul District does not make up 70 percent of the inventoried recreation acreage in the Upper Basin.) Also, the extent of "the area which includes Minneapolis and St. Paul" should be described. As written, it might be interpreted as being only the seven-county Metropolitan area rather than the 19,100 square mile headwaters area of the basin.

Response: The Upper Mississippi River Comprehensive Basin study area is divided into units which, as far as the St. Paul District is concerned, consist of the Northeast and Northwest units and the Mississippi River. Minnesota and several western Wisconsin counties with tributaries leading into the St. Croix River make up the Northwest unit. The remainder of the State of Wisconsin included in the drainage area which is tributary to the Mississippi River makes up the Northeast unit. The Mississippi River portion is that area immediately adjacent to the river. It is these three areas that contain 70 percent of the inventoried recreational area in the upper basin. The area referred to which includes Minneapolis and St. Paul is the entire Northwest unit and contains about 45,000 square miles.

Comment (18): Page 182, First Paragraph - It is our opinion that Exhibit 108 is in need of more consideration in this section. It is interesting to note that the recreational supply remains rather steady from 1980 to the year 2020 while the need increases considerably. It is difficult to visualize the rational for requiring an additional 2,825 acres of floodplain for the status-quo alternative for the next fifty years in the face of this increased recreational need and the rather static recreational supply.

Response: In order to accomplish the required dredging under current operating procedures, 2,825 acres are estimated to be needed to accommodate the dredged material. If recreation planning is considered it is possible that the supply of recreation areas could increase, but such development would have to be based on proper planning. The recreational need will certainly increase, but not all recreation need involves water use.

Comment (18): Page 182, First Paragraph - This rather minimal discussion of Exhibit 108 points out the need for safeguarding the existing fish and wildlife habitat from an economic point of view. There are no other feasible alternatives to safeguarding this recreational base. If

the whole recreational industry supported by the Mississippi River were calculated into this value, the need for resource protection would be much clearer. The value of this recreational industry may in fact overshadow the value of the 9-foot channel for barge traffic.

Response: Exhibit 108 refers to recreation in general and while it is not very specific it does provide a comparison. It would be incorrect to imply that this exhibit was meant to refer to each recreational activity individually. In addition, if it were possible at the present time to itemize the value of fish and wildlife habitat, such material would have been included. It is hoped that in the near future various State game agencies will be able to derive such values in a quantifiable and definitive manner. At such a time the information will be included in an updated statement.

Comment (6): Exhibit 109 utilizes only a small portion of the data available. Additional data should be included to show trends in these activities. Connecting the numbers to form a graph does little to help illustrate the data. Complete data for all years of record should be tabulated and the trends and reasons for the trends fully discussed.

Response: The exhibit utilizes the available pleasure boat lockages and demonstrates a nearly parallel increase in the 12-year period, 1960-1972. In the future, data will be collected to determine trends in boat types and sizes by personnel attending the locks and dams. At present no such data exists and therefore a tabular record would be of less value than the present graph.

Comment (10): We recognize the apparent lack of data on the total amount of recreational boating use of the navigation pools. However, some attempt should be made to quantify the true extent of this use other than by pleasure boat lockage figures. These are a poor measure of boating use because:

(a) they represent only numbers of craft and do not account for the great numbers of persons involved in watercraft use;

(b) A great number of recreational craft are not accounted for in such figuresbecause they do not go through locks; either their range of recreational interest is wholly within one pool, or the lengthy waiting time required for locking commercial barge tows discourages inter-pool movements (as noted on pp. 231-232 of draft statement); and

(c) to the extent that recreational lockages might provide some indication of the growth of river use for recreational boating, there is no reference in the statement text on the overall increase in recreational traffic indicated by increases in number of pleasure craft locked through as there is in terms of commercial waterborne traffic (as on p. 176); commercial traffic was said to have "about doubled" in the District from 1962 to 1971, so a similar summary statement for pleasure craft use is in order for the final EIS.

Response: The lack of adequate and accurate boating data presents a problem when an analysis or comparison is needed. However, using the limited data available, an increase was noted of about 50 percent during the period from 1960 through 1972. As more accurate information becomes available due to additional recreation use studies more accurate comparisons will be made.

Comment (6): Additional information is required on the capabilities of the locks to handle increased activity. Reasons for heavier use of certain locks should be given. There are other available studies of boating activity on the river that would be more useful than boat counts through the locks. The Upper Mississippi River Conservation Committee's Fisheries Compendium of March 1967 would be a good source, as would the UMRCC Sport Fisheries Survey of 1962-63 and 1967-68.

Response: If pleasure boat lockages could be distributed over a longer period of time such as 15-18 hours and 4-5 days in place of the current weekend use, each lock would have considerably greater capacity. One solution would be to construct another longer and wider lock to accommodate commercial tows more readily. At such times lockage schedules may be necessary. It is hoped that the current recreation use study will provide more up-to-date and accurate data and can be included in an updated statement.

Comment (18): Page 182, Second Paragraph, First Sentence - The statement is made that much of the increased pleasure boating on this portion of the river is made possible by "improved navigational opportunities provided by the system of locks and dams". It is extremely unlikely that most of these pleasure boats would require a 9-foot channel in which to operate, and most would probably be capable of operating at a depth less than 6 feet. Therefore, the relevance of this information to the 9-foot channel impact statement is questionable.

Response: It was inferred that with only a 6-foot channel no locks and dams would be present to assure an adequate level in the entire pool. The 6-foot depth was assured only if there was adequate water supply in the headwaters reservoirs which could be released during the summer season. The 9-foot channel not only assured increased depth, but a larger water area which could handle additional boats. The system of dams also provides greater depth in the back channels which contributed to the increased recreation boating opportunities.

Comment (18): Page 184, Second Paragraph, First Sentence - As stated previously, Wisconsin has five State parks on the Upper Mississippi River within the project area. The Kinnickinnic River State Park at the present time, however, only has a walk-in access to the St. Croix River.

Response: Subject information has been included on page 133 of the final EIS.

Comment (10): Pages 185-186 - The very limited discussion of sport fishing and hunting activities inaccurately implies that they constitute relatively minor uses of the river. The statement apologizes for the lack of "precise measures of the number of sport fishermen using each specific pool". However, to use the once-a-day count of fishermen seen from locks and dams by Corps personnel as the basic data is misleading as to the true extent of this activity. For example, in pool 4 the number of fishermen observed from lock and dam 3 (most of whom would have been in pool 4 below the dam) was 2,596, while the total visitation for fishing in pool 4 for the same year was estimated (in Exhibit 136) to be 169,200, or 66 times as great as the principal data offered. A similar serious understatement of hunting activity should be corrected. The statement cites only the figures for 10-year average annual estimates of 12,035 hunters in pools 4, 5, 5A, and 6 to show the significance of this "major activity." Using figures from both the statement and the assessment, a much more significant estimate of 66,900 hunters in pool 3 through 10 should be used. Hunting of other game, such as deer, woodcock, etc., should also be mentioned.

Response: The comparison of Exhibit 110 with Exhibit 136 is unrealistic since one is an actual count while the other is based on sampling and is an estimate. The exhibits should be reviewed only as a general comparison of counts at various locks during the years with an estimate for the entire pool. Only a recreation use study which considers all the factors on a day-by-day or season-by-season basis can provide realistic information and a true comparison. Additional discussions concerning hunting activities have been included where appropriate in the final EIS.

Comment (18): Page 185, Second Paragraph - It is our opinion that the discussion of the Upper Mississippi River for sport fishing and hunting is not adequate. The census techniques and methods for presenting these data have not considered the increased value of the Upper Mississippi River to sport fishermen and hunters. A great deal of information, particularly in relationship to the value of the Mississippi River to sports fishermen, can be obtained from consulting UMRCC fishery reports. In addition, the Department of Natural Resources has prepared a number of creel census reports on the Mississippi River.

Response: Appropriate changes have been made in the final EIS to include more data on commercial fisheries, sport fisheries, and hunting.

Comment (11): Page 185 - Precise creel census statistics are available for specific pools for certain years from the Upper Mississippi River Conservation Committee. Please contact the Coordinator's Office in Rock Island, Illinois.

Response: Subject material has been included where possible in the final EIS.

Comment (6): Exhibit 110 (page 185) makes use of only a small amount of the data available. Analyses of who the fishermen are, where they come from, how long they have fished and what they are fishing for are important questions that should receive consideration. It would be desirable to identify fishing activities in and around areas that are affected directly by dredging. Similar omissions exist in the discussion of hunting and hunters. The number of hunters, hunter trips, success ratio, and many other factors are needed. The interrelationship of dredging and spoiling and hunting should be addressed.

Response: Exhibit 110 utilized all of the data collected by Corps personnel at the locks and dams. The Upper Mississippi River Conservation Committee (UMRCC Study - October, 1970) 1967-1968 Sport Fishery Survey does gather data that are instrumental in determining information relating to fishermen. It may be desirable to determine what fishing activity is affected by dredging; however, at the present time no definitive data exists. A pilot recreational study is being initiated by the Corps and several States to determine what some of the recreational trends are and hopefully to answer the myriad of questions concerning them. The only data that exists for hunters pertains to success ratios and species taken published by the various fish and game departments, UMRCC and BSFW. Recreational hunting use data, as was suggested for fishermen, does not exist. The interrelationships of hunting and dredge spoil sites is complex but was approached on the section pertaining to impacts on terrestrial wildlife.

Comment (6): The statement is difficult to read and understand because of poor organization brought about largely by the separation of tables, graphs, and maps from the text. Moreover, the statement confuses the reader by repeatedly referring to and analyzing initial project effects on the environment rather than addressing the specific issue of "operation and maintenance." Reducing the sheer bulk of the statement may be difficult, but certainly this is a factor that hampers its readability. It appears that excessive wording could have been avoided. Pages 186 through 262, with references to Exhibits 111 to 172, are examples of excessive reporting. By reducing the 62 exhibits to 5 or

6 tables and including them in appropriate sections of the text, a more meaningful compliation of data would have been accomplished. Certainly, the location of information and comparison of pool data would be easier; and much redundance (Exhibits vs. Discussion) would be eliminated with a one section evaluation of the combined tables.

Response: We disagree. We feel that the method used represents the least complicated and repetitive manner to present the necessary data and gives a format that is thorough and understandable.

Comment (17): It should be recognized that although a substantial portion of the value of the Mississippi River results from recreational use, a point of overuse could be reached as has been demonstrated in several national parks. Before more recreational facilities and conveniences such as beach areas, faster recreational lockages, better access, and more harbor facilities are proposed, a determination should be made on how much stress could and should be placed on natural areas without losing more than is gained for the recreational user. Without adequate planning, development for recreation could be as potentially damaging as continued development for navigation.

Response: Concur.

Comment (20): The pool reports refer to the Metropolitan Council's Parks and Open Space Program in the land use discussion. The accurate reference is the Protection Open Space and Recreation Open Space chapters of the Metropolitan Development Guide; when appropriate reference should be made to the other Guide chapters. The discussions of land use should include more specifics on applicable land use plans and land use regulations.

Response: Corrected reference has been included in the final EIS.

Comment (6): Along the stretch indicated in the Socioeconomic Factors, Pool-by-Pool section are located a number of parks which have been developed along the banks of the river with assistance from Land and Water Conservation Funds. Dredging operations should be coordinated closely with the States to insure that the spoil placement does not affect, adversely, the park areas.

Response: Concur.

Comment (17): The draft Environmental Impact Statement omits any references to establishment of scientific areas by State and Federal agencies. This appears to be an oversite which shows a lack of thoroughness in approach. In combination with the Bureau of Sport Fisheries and Wildlife, the Wisconsin Department of Natural Resources has designated one State scientific area in the Nelson-Trevino Bottoms. Four other areas on the Wisconsin side of the channel are being studied as potential scientific sites. These areas which are under study for potential scientific area sites include: Bertom Lake, Turtle Island, Black River Bottoms, and the Kinnickinnick River Delta. It is assumed that similar areas may exist on the Iowa side of the channel.

Response: Subject information provided in the comment has been included on page 117 of the final EIS. As the impact statement is updated, additional scientific area information will be included.

Comment (11): Pages 186-257 - This pool-by-pool account of socioeconomic factors omits several important items:

1. The section on pool 5 should mention the importance of the area to large flocks of canvasbacks and swans, and the decline in aquatic habitat and hunter success.

2. Mention should be made of the high concentrations of canvasbacks which utilize pools 7 and 8 during the fall migration.

3. Trapping in general should be more thoroughly evaluated. No mention of trapping is made for pools 7-10. Beaver are a very important resource for the waterfowl habitat they create and maintain. Beaver are also a source of recreation and income to trappers.

Response: Subject information has been included in the final EIS.

Comment (4): Page 186-263 - The sections in this major subsection dealing with commercial fishing indicate, in several instances, that the commercial catch has benefited from the 9-foot channel project. Data and documentation should be included to support this contention, including value and production figures.

Response: The 9-foot channel project impoundments have greatly expanded habitat suitable for commercial fish species. The impoundments tend to act as nutrient reservoirs. This results in a very productive aquatic habitat. We believe that if a comparison between estimates of pre-impoundment and post-impoundment fish productivity could be made, one would find that the post-impoundment estimate would be higher. A comparison of commercial fishery landings in the Upper Mississippi River from 1894 to 1965 (Exhibit 107C) does not show a definite difference in catch between pre-impoundment and post-impoundment, but rather shows a great deal of fluctuation. The annual commercial catch is dependent upon many factors, only one of which is the quantity of fish in the river. Market demand influences prices which in turn influence the amount of effort put into commercial fishing. Data on fishing effort prior to the 1930's cannot be directly compared with post-impoundment data because of the inefficient record keeping during that time (Carlander (1954) p. 58). In addition, it would be difficult to compare pre-impoundment data with post-impoundment data due to differences in gear and methods employed in fishing. The subsection dealing with commercial fishing in the final EIS has been revised.

Comment (10): Pages 186-263 - Information for comparative analyses of factors in each navigation pool would be improved by adding the following to the text for each:

(a) percentage increase in recreational lockage counts, as was done with commercial lockages;

(b) dollar value data for commercial fish catch;

(c) use estimates for fishing, hunting and other recreational activities in terms of annual visitation or user days;

(d) estimates of forest product acreages and values.

Response: Additional information in the write-up would not appear to be necessary since most of the items referenced have been mentioned and described. With regards to (c), until an actual recreation area count is made pool-by-pool, there is no reliable information that could be cited without creating additional comments and questions.

Concerning (d), currently, there is no such information available, but when the lumber management plan per pool on the Mississippi River is completed data relative to timber resources will be available and can be incorporated into an updated statement. The only information available is that shown on the forest inventory overlays which contains no information concerning acreages.

Comment (18): Page 186, Second Sentence - The concentration of fish in the tailwaters below the locks and dams is probably more in response to food and rheotactile responses, rather than the higher oxygen levels. Most of the fish that inhabit the tailwater areas are species which are adapted to swift currents such as walleye, sauger, and white bass. The observation that most of the fishermen were located in the tailwaters based on Exhibit 110 is incorrect since the surveys were taken from the locks and dams. An examination of the UMRRC 5-year creel census reports may indicate that there are periodic concentrations of fishermen in other areas of the pool. For instance it is known that there are heavy concentrations of bluegill fishermen in the Brices Prairie area of pool 7.

Response: Appropriate changes have been made in the final EIS on page 134 Exhibit 110 refers to numbers of fishermen observed from the lock and dam and the fact that they were tabulated indicates that they must have been near the dam. The statement is, therefore, in agreement with Exhibit 110.

Comment (18): Page 186, Second Paragraph, Socioeconomic Factors Pool-by-Pool - The method for calculating changes in commercial and recreational lockages and this entire section is not consistent. For instance, commercial lockages are evaluated on a percent increase while recreational lockages are evaluated on the basis of an absolute number increase. It is requested that commercial and recreational lockages be evaluated on the same basis of either absolute number increases or percent increases. The current method of presentation makes it impossible to make any meaningful comparisons between the two.

Response: Concur. Appropriate revisions have been made in the pool-by-pool description on Waterborne Commerce in the final EIS.

Comment (25): The launching ramp at the river flats should be added on page 194, paragraph 2.

Response: Subject information has been included on page 139 of the final EIS.

Comment (35): On page 198, item 2, under the heading "Commodity, Origin, and Destination", the origin of the coal should read "East St. Louis, Kellogg, Ohio & Green River Docks".

Response: The origin "Kaskaskia-St. Louis" was intended to indicate a general location and, therefore, remains as stated in the final EIS.

Comment (35): On page 209, paragraph 3, in the subsection entitled "Waterborne Commerce", the third sentence should read, "In 1971, 1,193,062 tons of bituminous coal . . . ." instead of "lignite".

Response: The correction has been included on page 149 of the final EIS.

Comment (10): On page 210, reference should be made in the Recreation section acknowledging that the St. Croix portion of the 9-foot channel project is a State-administered portion of the National Wild and Scenic Rivers system under P.L. 92-560 and P.L. 90-542. The former Act provides that the statutory authority of the Corps for maintenance of navigation improvements is not impaired by the designation.

Response: Subject information has been included in the sections "Relationship of the Proposed Action to Land Use Plans" and "Projects and Proposals of other Agencies" in Section 2 and 3 of the final EIS.

Comment (10): Pages 210-211 - Studies more recent than the Minnesota Department of Natural Resources report give a more accurate picture of recreational use of the Lower St. Croix River. The Minnesota-Wisconsin Boundary Area Commission conducted watercraft use surveys during the summer months of 1970, 1971, and 1972. The Commission found that pleasure boating is by far the most popular use of the Lower St. Croix, with an average of 80,000 boat trips annually involving nearly 250,000 persons annually, for an average of 7.6 hours per trip. This amounts to over 600,000 boat-hours of boating. The Commission also estimated at least 15,450 manhours of water skiing, and about 8,800 camp nights of camping. Considering State and local park use as well as watercraft use and fishing use, there are well over 1 1/4 million recreational visits to the Lower St. Croix River annually.

Response: It would appear more reasonable to continue to accept and use data collected over a longer period of time, particularly when only one later year is included. As more detailed data become available over a longer time span it will be incorporated in an updated statement.

Comment (10): On page 211, the 100 "out-of-State" fishermen were from States other than Minnesota and Wisconsin. Two new State parks, Afton (Minnesota) and Kinnickinnic (Wisconsin), are being developed on Lake St. Croix.

Response: The sentence has been ammended to read "from States other than Minnesota or Wisconsin" on page 150 of the final EIS.

Comment (10): Page 212 - The word "Management" is omitted from Gores Pool 3 Wildlife Area. This omission also occurs in other places. All State game management areas are called Wildlife Management Areas.

Response: Subject information has been included on page 151 of the final EIS.

Comment (11): Page 213 - The most important commercial fishery in pool 3 is in North and Sturgeon Lakes in the southernmost part of the pool.

Response: Subject information has been included on page 152 of the final EIS.

Comment (18): Page 214, First Paragraph - It is suspected that the price fluctuations for the commercial fishery catch in this pool may vary due to the poor taste of the fish imparted by the influence of pollution. The percentages in the table at the middle of this page do not correspond with UMRCC data.

Response: Without a detailed study it is doubtful that such a statement could be made. The percentages referred to have been deleted in the final EIS and an average catch in pounds is substituted. It is expected that this presentation will be more meaningful.

Comment (11): Page 214 - Data on commercial fisheries fluctuates from year to year. We suggest using a 10-year average.

Response: The information has been incorporated on page 152 of the final EIS.

Comment (10): Page 214 - About 80 percent of the boaters mooring recreational craft at Hastings and Prescott in pool 3 are regular users of Lake St. Croix, not Lake Pepin. Recreational demand associated with Chicago is certainly not significant in pool 3; this would be more likely to be true for pools 7 through 10 in the District.

Response: Subject information relative to Lake St. Croix has been included on page 152 of the final EIS. The reference to use of pool 3 by recreationalists from Chicago has been deleted.

Comment (10): Page 217 - Since hunting is considered to be "the most popular productive type of sport" in pool 3, figures should be in the text showing estimated number of hunters and harvested waterfowl.

Response: The proximity of pool 3 to the Twin Cities Metropolitan area makes it very popular with sportsmen, particularly waterfowl hunters. The questionable water quality for body contact sports minimizes this type of activity. However, the numerous sloughs and backwaters attract fishermen seeking panfish. The main channel, with its deeper water, produces catches of sauger, walleyes and catfish. Information provided by the Minnesota Department of Natural Resources indicates that an opening day survey between 1961 and 1973 of the North Lake access that the number of hunters ranged from about 30 to 100. The number of ducks per hunter ranged from 0.53 to 1.66 and consisted primarily of wood ducks with some mallards and baldpate. No fishing surveys of note have been made of the pool.

Comment (11): Page 217, Lines 10-11 - Migrating waterfowl are not attracted in large numbers. In general, pool 3 is poor waterfowl area because of a lack of aquatic vegetation caused in part by fluctuating water levels and the presence of rough fish.

Response: Subject sentence has been deleted from the final EIS.

Comment (18): Page 219, Paragraph Three - The 1967 catch depicted in Exhibit 133 is 10,000 low.

Response: The corrected figure has been included in the subject exhibit.

Comment (18): Page 219, Last Paragraph, Last Sentence - Actually the prices have changed little on an annual basis just recently. At times, the demand drops when the market is flooded by large seine catches when the fish cannot be sold. Gear effectiveness, success in locating fish concentrations, and water conditions all have important influences on the commercial fishery catch.

Response: Comment noted.

Comment (11): Page 222 - Precise creel census data is available for 1962-63, 67-68, and 72-73 (not yet published) from Minnesota DNR and should be included.

Response: Concur. Subject information included on page 156 of the final EIS.

Comment (18): Page 222, First Sentence - We suggest that the UMRCC creel census be consulted to determine the number of fishermen visitations to pool 4.

Response: See previous Comment/Response.

Comment (10): Page 222 - Figure of 100,000 people in pool 4 zone of influence is inconsistent with 150,000 figure on page 218.

Response: Concur. The correction has been included in page 156 of the final EIS.

Comment (10): Page 222 - There seems to be a great discrepancy between figures showing estimated number of recreational visits to pools 4, 5, 5A and 6 for 1971 (Exhibit 137) and the total visitation figures in pools 4, 5A and 6 for 1963 (Exhibits 136, 147 and 152): it appears that there was 3 to 4 times as much recreational activity in 1963. Only the most applicable figures should be used.

Response: Exhibits such as 137 should not be utilized as direct comparisons since the methodology differs and can lead to erroneous conclusions. The total recreation use by pools as indicated in Exhibit 147 was extracted from the Corps of Engineers Mississippi River Master Plan. The data used in the master plan tabulation was based on a composite of both Corps of Engineers and Bureau of Sport Fisheries and Wildlife recreation compilation for 1963. On this basis, it would appear that such data could be the most accurate for that particular period. Until visitation counts are made annually or at least bi-annually there can be no true indication or comparison of recreational use.

Comment (18): In order to make the statement on page 233, first paragraph, first sentence it would be necessary to know what the waterfowl migrations were and what the hunter success rates were prior to impoundment.

Response: Comment noted. Although detailed information is not known to be available regarding the subject, it is believed that the statement is correct and should remain as is.

Comment (18): Page 223, Second Paragraph - Populations of certain fish species such as walleyes may have increased after the 9-foot channel project was implemented. Whether this increase has resulted in better quality fishing and hunting is less certain. After an initial period of high production, the amount and extent of fish and wildlife habitat now appears to be shrinking, and the river appears to be moving toward a single purpose channel with diminished recreational value. If this trend continues, it is certain that the recreational value of the Mississippi River will be less than that of the preproject river.

Response: Comment noted.

Comment (10): Page 223 - Second paragraph should appear in the general discussion of the entire District on page 180.

Response: Concur. Subject material has been included on page 131 of the final EIS.

Comment (18): Page 225, Last Paragraph, Last Sentence - It is not certain how the extensive commercial fishery in pool 4 would affect the commercial fishing in pool 5. It is assumed that the smaller acreage of pool 5 is probably a major factor in the smaller catch; however, this does not explain the drastic decline in the past few years. Again, the figures depicted in Exhibit 140 do not agree with UMRCC records.

Response: Subject sentence has been deleted from the final EIS. Figures depicted in Exhibit 140 were rounded off to the nearest 1,000; however, revised figures (to the nearest 100) are included in the final EIS.

Comment (18): Page 226, First Sentence - In order to make this statement, it would be necessary to know the catch of commercial fish and the type and amount of gear utilized prior to impoundment.

Response: The sentence has been omitted in the final EIS.

Comment (18): Page 228, Paragraph One, Last Sentence - By "Maintenance problems", it is assumed that it was intended to mean littering and sanitation problems. At the present time, littering is a major problem on small islands and sandbars formed by dredge spoil disposal. This problem will, of course, not be solved by ignoring it.

Response: It was not suggested that the littering problem associated with high intensity use of small islands and sandbars formed by dredge disposal be ignored. It was suggested however, that further encouragement is or should be avoided without adequate planning for waste removal, sanitary facilities, etc.

Comment (18): Page 228, Second Paragraph - As can be noted on Exhibit 37, pool 5 has been extensively degraded by dredge spoil deposits particularly in the Weaver Bottoms. It is our contention that the one-third decrease in catch in spite of a one-third increase in fishing pressure is indicative of current dredge spoil practices which forespells the future of this pool.

Response: Comment noted.

Comment (10): Page 228 - Reasons for the marked decline in number of fish caught in pool 5 should be offered. It is probable that the closure of backwater areas for spawning and rearing and disturbance of fish habitat in general are logical reasons for decline in fishing success in this pool.

Response: Comment noted. It is believed that generalizations with regard to decreases in fish production are adequately covered in other sections of the draft EIS.

Comment (18): Page 229, First Paragraph - It is our opinion that waterfowl hunter successes should be compared through the years, similar to that done for the creel census. It should be clarified that the average of 12,035 hunters and the average bag of 15,600 waterfowl annually is the total number for all four pools, and that the number of hunters and their success has not been segregated out for each of the pools.

Response: Subject clarification has been made on page 160 of the final EIS.

Comment (10): Weaver Bottoms is an extensive and controversial area in pool 5 and should be mentioned as a major fur-bearer and waterfowl habitat that is on the decline (as noted on p. 295).

Response: Reference to Weaver Bottoms is included in the final EIS on page 159 .

Comment (18): Page 230, First Sentence - It should be clarified that the closed areas are established by the Bureau of Sport Fisheries and Wildlife. For consistency, references should be made to all closed areas in each pool as they are discussed. Pool 4 is a good example of where this should have been done.

Response: Subject information has been included on page 161 of the final EIS. It is not felt that further discussion is necessary.

Comment (18): Page 231, First paragraph, Last Sentence - Again we see no documentation on the extent of commercial fishing in the region of the river prior to construction of the 9-foot channel compared to the level of commercial fishing in pool 5A after construction.

Response: The referenced statement has been revised in the final EIS on page 161.

Comment (18): Page 232, Third and Eleventh Lines - The inference is that "inviting sandbars" and "main channel and dredge spoil sandbars" are natural and aesthetically pleasing features. These inferences should be clarified by stating that often the sandbars are eroded and lack vegetation which renders them aesthetically unpleasing. The placement of dredge spoil material frequently destroys valuable waterfowl and fish habitat.

Response: Concur. Subject inferences have been removed from the final EIS.

Comment (18): Page 233, Last Paragraph, Second Sentence - The statement that "dredge spoil placement and sedimentation in recent years has reduced waterfowl habitat somewhat" is an example of continued vacillation and neglect in assuming the responsibility for the adverse impacts attributed to the operation and maintenance of the 9-foot channel project.

Response: The sentence has been modified such that "somewhat" has been deleted.

Comment (18): Page 236, First Paragraph - The trapping of furbearers in pool 6 is high, but is mostly restricted to private lands of which 5,000 acres or more are included within the Delta Fish and Fur Farm. Although the Delta Fish and Fur Farm is serviced by its own control structures, the wetlands in back of the dikes may be influenced by seepage water from pool 6.

Response: Subject information has been included on page 164 of the final EIS.

Comment (6): Three major pipelines cross the Mississippi River within the river reach covered by the statement. Northern Natural Gas Company owns an 8-inch pipeline that crosses the river at La Crosse, Wisconsin, and a 24-inch line that crosses between Dakota County, Minnesota, and Washington County, Wisconsin. American Oil Company has an 8-inch production pipeline that crosses the river near the common corner of Washington and Pierce Counties, Wisconsin, and Dakota County, Minnesota. The environmental statement makes no mention of the pipelines. As such, we suggest that the statement include information pertaining to plans of the Corps of Engineers for relocating or protecting the pipelines, particularly during dredging and spoil disposal operations.

Response: Records indicating submarine pipeline and cable locations are available to dredging crews. Dredge cuts at or near sites are carefully done to avoid damaging cables with either anchor spuds, cutterhead, or clamshell. Cable and pipeline locations are not utilized as spoil sites. In addition, submarine cables and pipelines are required to be at a minimum of 17 feet below normal pool elevation. This depth is considered adequate to insure that no damage occurs. This information is supplementary to that provided in the EIS, and is not essential to assist the reader in determining the significant impacts and effects of the operation and maintenance of the 9-foot channel project.

Comment (11): Page 238 - No data on the sport fishery is shown for pool 7. Data is available for pool 7 for 1962-63, 67-68, and 72-73 from the Wisconsin DNR and should be included.

Response: Subject information has been included on page 167 of the final EIS.

Comment (10): Page 240 - Information on trapping should be presented for pools 7-10. Hunting figures are lacking for pool 7.

Response: Information from State and Federal surveys have been included in the pool write-ups in the final EIS.

Comment (18): Page 240, Second Sentence - If pool 7 is not an origin or a terminal for barge traffic, why did the lockages through L&D number 7 increase more than those for L&D number 6?

Response: The increase in lockages at L&D number 7 compared with L&D number 6 is probably a result of the La Crosse residents boating up to pool 7 and then back without passing through pool 6.

Comment (18): Page 240, Paragraph 2, Third Sentence - These commercial fishery catch fluctuations are largely due to the presence or absence of large seine hauls.

Response: Subject information has been included on page 166 of the final EIS.

Comment (18): Page 242, Paragraph 2, Sentences Three and Four - Exhibit 158 does not distinguish between the fishermen counts at lock and dam numbers 6 and 7. It should be pointed out that the Department of Natural Resources has conducted spring and fall creel censuses on the pool 7 tailwaters for the past several years. This information would be more definitive than the simple counts of fishermen made by lock masters.

Response: Concur. Subject information has been included in the final EIS.

Comment (6): In the evaluation of changes in each pool, a disparity in the analysis has been introduced. Increases in commercial lockage for each pool are indicated in percentages while changes in numbers of recreation lockages are given as actual numbers. This gives the impression that commercial traffic is increasing rapidly while recreational traffic is increasing at a much slower rate. However, by using the limited data provided, recreational usage can be shown to have higher percent increase to avoid confusion and questions on counting procedures, actual numbers of both tows and recreational craft should be given rather than the number lockages.

When more data are made available, as in Exhibits 162 and 164, the longer term trends show up dramatically. Both commercial and recreational uses fluctuate, but over the 19 years of data provided, the changes favor recreational use. The following comparison of percent changes in lock use is taken from the statement and from computations using Exhibits 162 and 164.

Lock and Dam No. 8--Percent Increase in Use

	1962--1972	1954-1972
Commercial	28%	4%
Recreational	37%	3,794%

Lock and Dam No. 9 -- Percent Increase in Use

Commercial	45%	59%
Recreational	5%	797%

A 3,794 percent increase in recreational use on pool 8 or 797 percent on pool 9 is obviously not a valid indication of use or trends of use. However, these figures are calculated exactly as those given throughout the section for commercial traffic use, except that the base year is 1954 rather than 1960.

A better analysis of the comparative available data is required before the true setting can be known. The statement uses part of the available data in a manner that confuses the reader and justifies the continuance of the O&M purely for the sake of commerce.

Response: Appropriate changes have been made in the text to present commercial lockages in numbers rather than percentages. In agreement with comments received from the Minnesota-Wisconsin Boundary Area Commission data prior to 1960, Exhibits 162 and 164 have been omitted in order to make them more comparable with previously presented exhibits. It is believed that an adequate discussion of the setting has been presented without any bias towards over emphasizing commercial aspects to justify operation and maintenance activites.

Comment (18): Page 245, Third Paragraph, Second Sentence - It should be noted that two access sites are provided on the Minnesota side of the channel above and below the Interstate 90 bridge.

Response: Subject information has been included at indicated locations on page 169 of the final EIS.

Comment (18): Page 247, First Paragraph, Second Sentence - This large number of fishermen observed at the tailwaters of pool 8 is due primarily to the large population center adjacent to lock and dam number 7 and indicates the value of the walleye and sauger fishery in the pool 8 tailwaters.

Response: Subject information has been included on page 171 of the final EIS.

Comment (18): Page 247, Paragraph 2, Second Sentence - We feel that trends in waterfowl harvest rates and hunter success rates should be indicated.

Response: Concur. However, because such information is not readily available for all pools it would be inconsistent to indicate the data for only a limited number. An effort will be made to collect such information and incorporate it in an updated statement.

Comment (10): Page 250- Inclusion of information on agriculture in the pool 9 description is useful and similar information would enhance the understanding of other pools.

Response: Comment noted. Available information enhancing the description of any pool has been included whenever possible.

Comment (10): Page 256- To be consistent with other pools, fugures for pleasure boat lockages in pools 8 and 9 should be calculated from 1960 rather than from 1954.

Response: Concur. Exhibits 162 and 164 have been changed in the final EIS.

Comment (18): Page 256, Second Paragraph, Second Sentence - There are also fishing floats located below lock and dam numbers 6 and 7; however, they may not attract as many fishermen as the Clements fishing float.

Response: Comment noted.

Comment (10): Page 257- The more recent data in table 36 of the Environmental Assessment Report for hunting in pool 9 should be used. It shows an estimated 15,205 hunters in 1971 rather than the 5,375 used in the statement.

Response: The number used, 5,375 hunters, is an average number for the years 1961-1970, not just for 1971.

Comment: Page 257, First Paragraph - The sunfish species which were most important in the sport fish catch were probably bluegills.

Response: Sunfish species connotates other types of "panfish" in addition to bluegill.

Comment (18): Page 257, Paragraph 2 - It could be safely assumed that both sport and commercial fishing, and particularly sport fishing, would have probably increased whether or not the locks and dams were constructed.

Response: Comment noted. It is not believed to be a safe assumption as the data cited in the Environmental Assessment and draft EIS strongly suggest that impoundment significantly increased the available habitat.

Comment (41): Page 258- There is a boat landing in the backwaters of the Mississippi, accessible through Wyalusing State Park in Wisconsin.

Response: Subject information has been included on page 177 of the final EIS.

Comment (10): Page 260- Change figure 3,300 to 5,500 for boats locking through lock 9 in 1972.

Response: Correction has been made on page 178 of the final EIS.

Comment (6): In order to determine the environmental impacts that have been made, and will continue to be made, a base must first be established for valid comparison of the impacts. This has not been done. As the impacts are discussed throughout the statement, there seldom is any attempt to determine how these impacts were established or to provide comparative basepoints.

For instance, in the section Major Beneficial and Adverse Impacts of the 9-Foot Channel Project, Subsection Fish and Wildlife, the increased space for aquatic vegetation and animal life is referenced. There is

no basis for this generalization. The statement should indicate the years being compared and describe the changes in acreages of aquatic and terrestrial habitat. Finally, this section should describe actual economic, social, and environmental gains and/or losses. With this information, the reader would be able to define the long-term trends in habitat change.

Response: Available baseline data pertaining to the pre-impoundment environmental setting are adequately presented in the draft EIS. More recent baseline data studies were initiated in 1973 to gather as much information as possible. A contract was initiated with North Star Research Institute (Minneapolis, Minnesota) which was in turn subcontracted to various investigators. Information was then compiled and presented in Environmental Impact Assessments for each navigation pool in the St. Paul District.

Furthermore, additional contracts dealing with habitat inventories, plant succession, and revegetation of dredged material are currently under contract.

It is believed that such data will be meaningful and provide further insight into current problems. A considerable amount of the data made available through these current contracts will be included in future reports.

Comment (10): Pages 263-264- The statement should be more specific in its discussion of project impacts on terrestrial and aquatic areas. For example, the Environmental Assessment Reports for pool 7 (Table 5) and pool 8 (Table 4) show acreages of ecotypes prior to and after closure of dams 7 and 8 respectively. These give a real measure of the environmental effects of the project and allow decision-makers to measure and evaluate the trend of changes in habitat base resulting from continued O&M. Such information should be included in the EIS for each component of the system.

Response: The purpose of this EIS is to define the environmental impacts of the O&M activities and not the initial implementation of the project. Those impacts associated with the project that are felt pertinent to understanding the impacts of O&M activities are discussed in Section 2 of the EIS. However, to provide more information in this regard, a contract active at this time is generating, via the interpretation of various types of remote sensing imagery, data pertaining to the acreages of various habitat types, spoil deposits, etc. Baseline maps will be developed which delineate these acreages in 1973 and 1939. This information will be made available as soon as it is received.

Comment (3): Page 263- Impacts on topography and geology. It is suggested that this first paragraph be expanded to demonstrate more specifically the sources of sediment.

Response: The requested material is covered in detail in Section 2.

Comment (10, 18): Page 263 - Hunting figures for pool 10 should be updated; the 9,000 figure used is in Exhibit 172, not 165.

Response: Concur on exhibit reference. Hunting figures were believed to be the most recent available and are also contained in the Environmental Assessment.

Comment (18): Page 263, First and Second Paragraphs - We find that the only impacts which have been summarized are the beneficial impacts. This entire section is inadequate. The importance of slough openings are understated and the effects of subsequent erosion and secondary movement of spoil disposal areas are glossed over. The most important consideration is the vast alteration induced by the locks and dams which were largely completed in the 1930's. At this time, we are looking at 35 to 40 years of successional changes. These changes are not at an end; however, many short-term changes have occurred and some stabilization has been achieved although the operation and maintenance of the project still produce continued disturbance. It should be emphasized that continued ecological changes, related to succession, are occurring and will occur in the future. Thus, with this continued successional change, the Mississippi River will not be the same in another 35 to 40 years, should the present operation and maintenance of the 9-foot channel continue. It should also be recognized that any environmental benefits arising from the construction of the original project will have been completely negated by that time. The environmental benefits which are indicated in this Environmental Impact Statement will at some time in the future be termed short-term uses of man's environment to the detriment of long-term environmental productivity.

Response: Comment noted. The Summary of Major Beneficial and Adverse Impacts of the 9-foot Channel Project Section has been revised in the final EIS.

Comment (10): Page 263 - The second opening paragraph in the Summary of Major Beneficial and Adverse Impacts of the 9-foot Channel Project is oversimplified and seriously unbalanced. Any such summarization should at least acknowledge the major beneficial and adverse impacts cited in the discussion which follows it: e.g., the project impoundments increased the rate of accumulation of sand and silt in the floodplain; decreased oxygen concentration in backwater sloughs; altered river flow patterns; increased aquatic environment; etc.

Response: Comment noted. The summary has been revised for the final EIS.

Comment (6): The Summary of Major Beneficial and Adverse Impacts of the 9-foot Channel Project, page 263, again implies that there are only beneficial impacts from the project; yet, the detailed section under that heading discusses some adverse impacts. For that matter, other

summary sections throughout the statement show bias in presenting beneficial impacts but adverse impacts are often ignored or not addressed fully. Since the summaries are misleading, it becomes almost impossible to evaluate project impacts - beneficial or adverse. Unfortunately, this false note will be subscribed to by the average reader who will have a tendency to review only the summaries because of the voluminous nature of the statement.

Response: Comment noted. The summary has been revised for the final EIS.

Comment (10): Impact of the 9-foot channel project impoundments on the rate of accumulation of sand and silt in the floodplain has been substantial. The word "somewhat" on page 263 is inappropriate and meaningless.

Response: "Somewhat" has been removed from the final EIS.

Comment (11): Page 263- The rate of sedimentation is more a function of sea level than the locks and dams. However, the impoundments do affect the site of the natural phenomenon of sedimentation and therefore the rate of sedimentation locally, for example, at the sites of the lock and dams is increased.

Response: The rate of sedimentation, the action or process of depositing sediment, is a function of several interrelated parameters and variables such as particle size, shape, and specific gravity; velocity of flow; etc. The presence of the locks and dams has affected some of the variables (for instance, velocities are reduced) such that the rate of sediment deposition apparently has increased. The rate of sedimentation within the St. Paul District is not related to the sea level at the mouth of the Mississippi River as the comment might seem to imply.

Comment (18): Page 263, Third Paragraph, First Sentence - This sentence should be changed to read: "The impoundments have increased the rate of accumulation of sand and silt in the floodplain." It is unacceptable to say that the effects of the locks and dams on the rate of sedimentation are now known and cannot be predicted. If the last sentence of the first paragraph on page 264 is taken literally, one would have to question the acceptability of the locks and dams at any level of resource value consideration.

Since the majority of the Mississippi River sediment is coarse-grained and is carried as bedload along the channel bottom, the dams have had a much more significant effect on reducing the sediment carrying capacity than is indicated here. Under natural unimpounded conditions, the locations of the channels very likely shifted with erosion, but were at some state of equilibrium in which the overall profile of the river was more constant than it is in the impounded state. It is stated in the first paragraph of page 264, that there are no means of predicting the length of time required to fill the pools with sediment to

a level even with the crest of the dam spillways. It would appear that if the Corps had any confidence in Exhibit 65 (the curve relating the capacity inflow ratio to the trap efficiency of the pool) the data contained herein could be used to determine the length of time required to fill a given pool by using progressively smaller volumes of storage based upon the sediment inflow of the previous season. In addition, it appears that the calculations of some of the principal investigators have been ignored. For instance, it has been estimated that 20 to 40 percent of the capacity of pool 7 has been lost to sedimentation since its installation. Thus, it would appear that the statement that it would take a thousand years for the pools to fill is extremely incredulous. We would like to know why the sedimentation rates and water loss from areas other than the main channel cannot be measured. It is our position that this impact statement should attempt to answer those critical questions instead of counting the number of boat landings, the number of recreational lockages, the number of commercial lockages, and similar meaningless data which are peripheral to the real issue of the adverse impacts which can be attributed to the operation and maintenance of the 9-foot channel project.

Response: The first sentence, third paragraph, has been changed accordingly. The remainder of the comment is incorrect in claiming that the majority of Mississippi River sediment consists of bedload. As discussed in Section 2 of the draft EIS, available data indicates that the majority of sediment within the Upper Mississippi River Basin is suspended load.

The trap efficiency method is not a reasonable method for estimating pool life because, as discussed in Section 2, it is not intended for extremely shallow reservoirs with little storage. Obviously, as the navigation pools continue to fill with sediment, this method becomes increasingly inappropriate. To calculate sedimentation rates and estimate pool lives with reasonable accuracy, a multi-year surveying program to get perennial soundings of both channel and backwater areas would be necessary.

In questioning the appropriateness of presenting recreational and commercial boating data in this EIS, the commentor apparently would elect to ignore these rather significant economic and social impacts of the 9-foot project. The Corps has attempted to consider all aspects fairly and, to the maximum extent possible, comprehensively. Where data were readily available, as with commercial and recreational lockages, the information was presented and discussed appropriately. Where data were not available, as with many sedimentation issues, the Corps did not jump to unsupported conclusions. Instead, the Corps informed the reader that such data were lacking and attempted to present a qualitative discussion including all reasonable alternative conclusions. This may have given the unfortunate impression that a disportionate amount of time and effort was spent collecting "meaningless" data at the expense of satisfactorily resolving certain "critical questions". This was not true.

Comment (11): Page 264, First Paragraph, First Sentence - The report states "But the closing of the dams somewhat decreased the River's ability to transport silt and sand." The ability of the river to transport sediment is not decreased, but rather the sediment transported is decreased. The river will naturally attempt to make up for its lost sediment load via channel scour.

Response: The decrease in sediment transported is due to the river's decreased ability to transport it, largely because of the slower velocities in the pools compared to the pre-project river. Immediately downstream of the locks and dams, where the river most nearly approaches its original natural state, the ability of the river to transport material is enhanced by the loss of sediment in the pool directly upstream. This is evidenced by localized scour.

Comment (18): Page 264, First Paragraph, Second Sentence - The uppermost one-third of the pools resemble the preimpounded river only in general aspects. In many respects, the environment of the upper pool has been significantly altered since the sloughs do not run as fast as they did in the past, the floodplain lakes and marshes no longer dry up in dry weather cycles, and in general, sedimentation is occurring at a faster rate.

Response: Comment noted. The sentence was written in the draft EIS such that the qualification "generally" does in fact precede the remainder.

Comment (3): Page 264 - "Some have indicated that it (sedimentation) is taking place at an alarming rate." State reference: "The impoundments have increased somewhat the rate of accumulation of sand and silt in the floodplain."

Response: The text has been changed to clarify subject sentences on page 180 of the final EIS.

Comment (10): Page 264 - It is surprising to note that "there are no scientific estimates available" as to how long it will be before "the sediment level eventually reaches the crests of the spillways of the dams." Sedimentation rates are one of the key factors considered in Corps impoundment projects throughout the country. This is clearly an area that deserves to be analyzed and reported in an EIS.

Response: Sedimentation studies are normally accomplished with Corps-designed reservoirs. However, records of any such studies for the navigation pools which would tell us what assumptions were made and what data were originally collected is not readily available. For a few years following construction of the locks and dams, sedimentation studies of the pools were conducted. These studies were discontinued when preliminary results indicated that the life of the pools would be far in excess of the replacement life of the locks and dams (50 years).

Comment (11): Page 265, Second Sentence - "The water column in the isolated sloughs and river lakes tends to stratify ....." We cannot agree with that statement. We have not evidenced any floodplain water areas stratifying with a thermocline present.

Response: Water quality data obtained during the summer of 1973 under the environmental impact assessment studies contracted with North Star Research Institute indicated the presence of thermally stratified floodplain lakes and sloughs within the study area. These reports were made available to the public.

Comment (18): Page 265, First Paragraph, Second Sentence - In a section which should contain a detailed description of environmental impacts, it is found that the best that can be done is, "The general tendency is for backwater sloughs of rivers, lakes and ponds to become isolated from the main channel by a combination of natural movement of sediments, floodplain construction, and by the dredged material." It is essential to know specifically how much of this general tendency can be attributed to each of the following factors: natural movement of sediments, floodplain construction, and dredge spoil disposal practices.

Response: The referenced section contains environmental setting information and not a detailed description of environmental impact.. Refer to Section 4 of the final EIS for description of environmental impact of O&M activities. The impacts which are presented in the Environmental Setting section of the EIS are impacts related to project implementation and are presented to give the reader a better understanding of the role of the project as related to the existing environmental setting.

Comment (18): Page 265 - The separation of backwater lakes and ponds from the main channel would be looked upon as an adverse affect on water quality as stagnation, oxygen depletion, and sedimentation result when the backwater areas are no longer in communication with the flowage streams.

Response: Comment noted.

Comment (18): The "floodplain construction" and disposal of dredge spoil in these areas would probably be contrary to Wisconsin Law and/or to Floodplain Management Standards.

Response: "Floodplain construction" and disposal of dredge spoil in the referenced areas might be contrary to Wisconsin Law and/or to Floodplain Management Standards, however, these would have to be determined on a case-by-case basis.

Comment (18, 10): Page 266, First sentence - The impoundment of the Mississippi River has benefited certain fish species and has harmed others. Thus, the increase in pounds of fish has not been an entirely positive impact. Most of the total increase in poundage of fish can be attributed to the proliferation of species such as carp and sheepshead which are of relatively low value for sport fishing.

Response: We believe that the change in species composition of fish resulting from impoundment has been adequately treated in Section 2 of the final EIS.

Comment (4): Page 266 - The statement on this page referring to "The great commercial catch of fish in the area ... " as a result of the project neglects to mention the important factors of market demand and improved technology in fish capture and processing.

Response: The factors of market demand and improved technology certainly would contribute to the commercial fish catch. However, we feel that the expansive increase in commercial fish habitat resulting from impoundment is the primary factor for the large commercial catches taken in the last 30 to 40 years.

Comment (18): Page 266, Second Paragraph, Third Sentence - This should not be construed to mean that the unimpounded river would not also have a productive sport fishery given liberal regulations.

Response: It was not the intent of the draft EIS to imply that the "unimpounded river" would not have a productive sport fishery. However, the "unimpounded river" mentioned above would probably be dominated by "fast water" fishes such as smallmouth bass and perhaps walleye. The existing sport fishery is dominated by panfish, walleye, largemouth bass and northern pike. Although comparative data is not available, we feel that the existing fishery provides a higher sustained yield than would be the case with the "unimpounded river" sport fishery.

Comment (18): Page 266, Third paragraph, second sentence - A natural unimpounded river is quite capable of producing abundant food for fish. Pool "production" areas and tailwater "feed lots" are not essential to a good sport fishery. The aesthetic and sport fishing potential of tailwater concentrations of fish is beginning to result in the congregation of more fishermen than is desirable. Good sport fisheries, particularly for bass, existed in natural floodplain lakes which were subjected to fluctuating water levels. These fisheries would have existed naturally without the necessary fish rescue work.

Response: It is inconsistent to say that these fisheries would have existed naturally without the necessary fish rescue work. Carlander (1954) cites many examples of successful fish rescue operation which were necessary due to falling water levels and/or impending winter kill conditions.

Comment (10, 6): Page 266 - While stabilization of water levels by project impoundments made fish rescue work in isolated floodplain pools "unnecessary," it should be pointed out that many such problem areas were probably cut off by earlier channel modification works such as wing dams and closing dams.

Response: The final EIS has been revised to include information from the above comment on page 182.

Comment (18): Page 266, Third Paragraph, Third Sentence - This fish rescue work was probably done as a public relations effort rather than out of biological necessity. Modern day fishery management techniques seldom rely on fish rescue work except for the harvesting of species which could be utilized to populate new waters.

Response: We agree that modern fishery management techniques would not rely heavily on fish rescue work. However, the statement that fish rescue work was probably done for public relations purposes rather than biological necessity is not supported in Harriet Carlander's book entitled, History of Fish and Fishing in the Upper Mississippi River, 1954.

Comment (18): Page 266, Third Paragraph, Fourth Sentence - The fluctuating water levels which cause fish to be stranded in floodplain pools could be largely attributed to the wing dams and closing structures installed for the 4 1/2-foot and 6-foot channels. The resulting increased hydraulic efficiency of the channel resulted in the isolation of backwater areas and sloughs as more water was shunted down the main channel. In reality, a natural river system very seldom has fish kills or stranded fish unless there are incidences of gross pollution. Thus, the implication that the Corps of Engineers has saved the Mississippi River fishery from extinction through the construction of the 9-foot channel, is not correct. In fact, current dredge spoil disposal practices have resulted in the isolation of backwater areas, trapping of fish in stagnant pools and subsequent fishkills.

Response: Fluctuating water levels are the result of rising and falling river stages (which are the result of inflow and discharge rates), and cannot be attributed to the wing dams and closing dams of the 4 1/2 and 6-foot channels. However, in the past when falling river stages combined with effects of the wing dams and closing dams, fish could have become entrapped behind the dams. The same phenomena occurred in natural floodplain lakes, sloughs, and marshes (as indicated by Carlander, 1954). When fish became entrapped behind man-made or natural barriers due to falling river stages, fish rescue operations are necessary to save the fish. It was not the intent of the draft EIS to imply that the 9-foot channel saved the Mississippi River fishery. The wording of the referenced paragraph has been revised in the final EIS to reflect information from the comment. We do not know of any documented evidence to support your claim that current dredge spoil disposal practices have resulted in "isolation of backwaters, trapping fish in stagnant pools and subsequent fish kills." If an

agency has such evidence we would appreciate being made aware of it. We feel that secondary movement of dredge spoil is implicated in the occulsion of guts and side channels, but the degree of implication is not known.

Comment (10): Page 266 - The statement that "wing dams effectively increase the total area of river bottom for invertebrate production" is accurate only where such structures are not subject to heavy sedimentation. As the EIS points out (page 80), there has been considerable sedimentation between and behind wing dams and closing dams. The long-term cumulative effect of such sedimentation is to reduce habitat rather than increase it.

Response: Comment noted.

Comment (18): Page 267, Paragraph 1 - It is probably correct to say that the 9-foot channel project increased muskrat habitat. However, since beaver typically locate on the flowing side of channels and sloughs, it is questionable whether the creation of marshes and lakes helps them significantly.

Response: Comment noted. The qualification "probably" has been included in subject sentence on page 182 of the final EIS.

Comment (18): Page 267, Second Paragraph, Fifth Sentence - The wing dams were not really part of the 9-foot navigation project, but were left over from earlier attempts to channelize the Mississippi River. They were accidently covered to the depth which prevents complete siltation behind them and provides good fish habitat. Rock bass are not one of the main panfish species in the fishery catch; however, they are quite numerous in areas without rock rubble. Wing dams are important to walleye, however.

Response: Comment noted. "Rock bass" has been deleted in subject sentence and "walleye" substituted in its place on page 182 of the final EIS.

Comment (11): Page 267 - Second paragraph (wing dams). Mention should be made that spoiling on these wing dams has reduced and eliminated valuable aquatic habitat.

Response: Whenever and wherever possible, spoiling directly on wingdams has been avoided.

Comment (10): Page 268 - Another paragraph is needed on effects of closing of chutes and backwaters. The discussion of conditions unsuitable for fish on page 265 more properly belongs in this section.

Response: Comment noted.

Comment (10, 6, 11, 18): Pages 268-269 - The EIS overstates the beneficial impacts of the project on recreation and aesthetics. Sand beaches created by dredge spoil deposition for miles along the main channel may be "beautiful" for certain purposes; but to many people who place high values on natural environmental settings, they represent an artificial scar on the riverscape. As the discussion of the impacts of spoil vegetation states on page 367, "the unnatural appearance of unvegetated, linear, continuous spoil deposits bordering the navigation channel could be eliminated."

Response: Comment noted. "Beautiful" has been deleted from subject sentence.

Comment (10): Citations of the provision of boat launching facilities, scenic areas and observation platforms "incidental to the navigation project" and of the "Master Recreation Plan for the Project" are valid, but the public should know that Corps operation and maintenance of public recreation facilities in the 242.5 miles of rivers in the St. Paul District of the project constitutes only 1 percent of the annual Corps District budget, or about $65,000 in Fiscal Year 1974. Reference to the invention of water skiing "on post-impoundment Lake Pepin" should be eliminated; such a claim more properly belongs to the originator of the activity and should be left to the promotional literature of the Lake City Chamber of Commerce.

Response: Comment noted in regards to the Corps District Budget. The reference to water skiing has been deleted from the final EIS.

Comment (18): Page 268, First Paragraph - This paragraph is not clear as presently written. The implication is that Lake Onalaska has been cut off from the main channel water supply due to increased aquatic habitat. This implication is not correct since Lake Onalaska has been separated from the main channel by natural islands and dredge spoil disposal practices.

Response: We concur that the statement regarding Lake Onalaska is not clear. Since Lake Onalaska was formed by the creation of pool 7 and except for a few openings, a natural ridge separates the Lake from the main channel of the river, the detrimental effects referenced here are unclear. This sentence has been deleted from the final EIS.

Comment (18, 6): Page 268, Second Paragraph, Second Sentence - Only a small amount of the dredge spoil areas are accessible from the main channel of the Mississippi River since much of the dredge spoil material is deposited in backwater marshes and sloughs. The recreational use of some of the dredge spoil areas is discouraged by the highly eroded and steep edges, extreme height to which the dredge spoil material is placed (sometimes in excess of 30 feet), and the lack of vegetation.

Response: Comment noted.

Comment (11, 18): Page 269 - Waterskiing is not dependent on continued operation and maintenance in Lake Pepin. This statement makes it appear as though the invention of waterskiing was in some way affected by the project. This is totally false. Waterskiing could have been invented on Lake Pepin even if there was no project at the time. Lake Pepin is a natural lake and would have existed without the locks and dams. This appears to be another example of attempting to gather as many beneficial effects of the project as possible while de-emphasizing the adverse impacts of the project. Towboats and dredge spoil may not be aesthically pleasing to some people because they contrast with the naturalness of the river setting.

Response: Subject discussions have been removed from the final EIS.

Comment (6, 18): The discussion of difficulties encountered by recreational traffic on the river from long waits at locks is not complete. The priorities that exist for use of these public facilities should be listed and explained. Since the channel is maintained primarily for the large commercial barges, it would add to the statement to explain why the main users of the deep channel do not have to pay for the use. Most recreational craft can navigate on the river without the aid of dredging so their cost would be much less for use of the locks. Since the holidays create a particularly bad conflict at the locks, the statement should evaluate the possibility of restricting barge traffic on specified holidays much as trucks are prevented from disrupting traffic during peak road use.

Response: Refer to the discussion of lock operation in Section 1 of the final EIS for a discussion of locking priorities and procedures. The information regarding waiting periods incurred by recreational craft at the locks is considered adequate to convey the problem to the reader of the EIS. The subject of user fees relates to project justification and the beneficiaries. The 9-foot channel project provides benefits to people over a widespread area. The effects of implementing user-fees on watercraft that use the system would probably have little effect on alleviation of adverse environmental impacts of present O&M procedures. A discussion on the relative merits of user-fees is not believed appropriate for this EIS. Information regarding alternatives to current locking procedures and policies is contained in the Alternatives section of the final EIS.

Comment (10, 6): Under adverse impacts, the aesthetic appeal of the riverscape has, indeed, been "locally reduced due to urban development of riverbank property;" but it should be noted that a significant amount of this development was attracted to the riverfront by the navigation project. Also, dredge spoil from the project has reduced the aesthetic appeal, as was previously noted. In terms of the impact on recreational boating, it should be noted that the installation of the locks and dams of the project serve as barriers to free movement of watercraft on the river. Because of time-delays often encountered at

locks due to commercial tow operations, many users are effectively forced to confine their recreational boating use to a single pool. This factor is a constraint on the public's enjoyment of the full range of river recreational opportunities.

Response: Comment noted. Suggested alternatives to present commercial-recreational lockages have been noted in the final EIS.

Comment (6): Inundated wing dams and closing dams are recognized as being navigation hazards but usually are unmarked (page 269). It would appear that this hazard could be minimized and, therefore, should be discussed.

Response: Subject discussion has been added on page 183 of the final EIS.

Comment (18): Page 270, First Paragraph, First Sentence - The statement is made that "the project removed farming operations from a high risk flood area." The project has quite possibly meant that areas which previously may not have been flooded are now subject to inundation due to the loss of channel storage below the existing pool elevations. Therefore, while land use has been transferred from areas which previously were adjacent to the channel, other land use now adjacent to the pools may in many cases be subject to inundation.

Response: Comment noted.

Comment (10): Page 270 - The second paragraph on "Impacts on Land Use" belongs in the discussion on surface water. The existence of the project has also created problems of law enforcement on the river in areas where channel modification has changed the main thread of the stream. For many miles, the "main channel" no longer follows the natural course which is the legal interstate boundary line.

Response: Comment noted.

Comment (18): Page 270, Second Paragraph, First Sentence - The existence of the pools has not led to a direct effect on cooperation between State natural resource departments in the management of fish and wildlife resources. It would be no more troublesome to negotiate reciprocity between adjacent States if the river were not impounded. In fact, it may simplify rule-making and increase management efficiency.

Response: Concur. Subject sentence has been modified to refer to "a need for greater cooperation" on page 184 of the final EIS.

Comment (18): Page 270, Third Paragraph - It is implied that public ownership of lands in the river bottoms is due to the 9-foot channel project. While this may be the case due to the manner in which the project was initiated, such public ownership of the bottom lands is certainly not dependent upon the maintenance of a navigation channel in the river and could be accomplished separately.

Response: Concur. However, the reference is so stated that "the 9-foot channel project" implies initiation rather than maintenance as the factor that assured public ownership and control.

Comment (11): Page 270, Paragraph 3 - Public ownership and control of lands in the river bottoms does not assure their preservation as a haven for wildlife and fishes. Only those lands owned outright by the Bureau of Sport Fisheries and Wildlife and Minnesota and Wisconsin Departments of Natural Resources give these assurances. Other lands owned by the Corps, municipalities, or other governmental agencies can be used for most any type of development desired. Even though the Corps leases lands to the Bureau of Sport Fisheries and Wildlife expressly for fish and wildlife purposes, the contract between these two agencies can be broken at anytime by the Corps and the land used for industrial and commercial developments.

Response: The agreement between the Department of the Army and the Department of the Interior (Bureau of Sport Fisheries and Wildlife) signed 14 February 1963 sets forth the following provisions for revocation:

1. In case of National Emergency declared by the President.

2. Event of violation of terms and conditions, which violation is continued for a period of 30 days after written notice by the responsible Division Engineer or for nonuse for a period of 2 consecutive years.

3. Relinquishment by the Bureau at any time after 30 days notice.

The Corps' concern as applied to the concept of "multiple use" management is well known. Within the framework of this concept and the above listed items, revocation of the agreement is not likely and certainly not to be acted upon as a whim by the Corps as the comment suggests.

Comment (10): Dedication of bottomlands has assured their preservation as a haven for wildlife (but not fishes) to some extent; however, dredge spoil deposition from the project is having an adverse impact on many such lands (as noted on pp. 308-312). This inconsistency within the report should be balanced by expanding the statement.

Response: An expansion of the statement on this issue is not warranted at this time. It is believed that sufficient information regarding impacts of dredged material and wildlife habitat has already been discussed in the statement.

Comment: The introductory summary paragraph (p. 263) cites "shaping of urban growth ... to take advantage of ... navigation potentials ..." as a social impact of the project. Since "increased development of commercial docks and industrial complexes along the river" is cited as an economic impact (p. 271), one of the major land use impacts not

mentioned is the attraction of such facilities to riverbank lands by the project. It would also be fair to point out that many such developments are also damaged by flooding, a factor which is the reverse of the situation cited regarding removal of farming operations from "a high risk flood area". There is usually a public cost involved in either protecting or rehabilitating these flood-prone facilities.

Response: Subject information has been included in the Relationship of the Proposed Action to Land Use Plans section.

Comment (23): The Corps likes to list their employment costs as benefits. The Water Resources Council, however, has stated that these costs may be deemed benefits only if the area of employment has been designated as having unemployed or under-employed labor resources. There was no evidence that this area has been so designated, and until such time, payrolls must be listed as costs.

Response: It is not believed that the statement lists salaries as benefits from the project. The economic impacts section lists economic benefits as those derived from increased development of commercial docks and industrial complexes. Economic costs of lock and dam maintenance are listed as such in Section 8, Irreversible and Irretrievable Commitments of Resources.

Comment (24): Almost all of the discussions regarding the economics of river-use for transportation are based on the assumption that barge transportation costs are less than other transportation forms. This assumption that barge transportation is "cheaper" has been hotly disputed by many and is relative to rates versus complete costs. Therefore, all the statements based on that assumption might very well be misleading or even erroneous. There is a clear need for a detailed inter-agency study of transportation of all types in the Upper Mississippi River Basin. Such a study should be undertaken immediately and the results should be part of all future environmental impact statements for navigation related projects.

Response: We concur that studies would be desirable to help determine a clearer understanding of the interrelationship of the various transportation modes in the Upper Mississippi River Basin. If these studies were done, they would then be available for possible inclusion in future impact statements regarding any transportation modes.

Comment (25): The Corps' contention that barge traffic is superior to alternative forms of transportation is dubious at best. The alleged savings materialize from a comparison of barge rates with rates prevailing on alternative forms of transportation on a ton-mile basis. The Corps conveniently overlooks the fact that in order to deliver goods between any two points, barges must travel a greater number of miles. Also, nowhere are the very real costs of the operation maintenance of the channel included. The admitted considerable savings

unfortunately accrue to only the waterway shippers and their customers, not to the general public. To be rightfully listed as a benefit, the advantages should flow to the public as a whole.

Response: An examination of public welfare theory reveals that the public does indeed receive a benefit in lower cost of goods and services due to a smaller transportation bill. The commodity market also recognizes transportation costs in prices bid at various geographical locations. To the extent that the transportation bill is minimized both the consumer and the producer in this country benefit from a better competitive price for exports.

The greater number of miles is not conveniently overlooked. Ton-miles are used for rate comparison. The savings between the next cheapest alternative fully accounts for cost-savings to shippers.

Comment (9): The maintenance of the 9-foot navigation channel is essential to the continued operation of fossil-fuel burning electric power plants located along and adjacent to the channel in that it provides waterborne transportation for coal and petroleum. Continued operation of these plants is necessary to assure reliability of electric power throughout the Upper Mississippi Basin.

Response: Comment noted.

Comment (12): The tremendous long range economic expenditure amounting to billions of dollars for the operation and maintenance of the channel for use by commercial transportation concerns warrants a more detailed investigation of the economics justification of the project. Such an investigation should include a comprehensive assessment of existing and potential transportation facilities and their relative economic value as an element of a national transportation system.

Response: The economic justification of a very successful integrated waterway transportation network is not addressed in this EIS. Unlike most Federal expenditures, water resource investments are economically justified in a project document. The Environmental Impact Statement is not a vehicle for economic re-determination which has previously been established and approved by the legislative process. The comprehensive transportation assessment is not essential to the purposes of this EIS.

Comment (15):
1. The draft EIS does not discuss the need for a survey which would locate and identify archaeological or historical sites or historical objects, such as sunken riverboats, prior to any dredging operation.

2. The draft EIS does not discuss or intimate the need for the scientific recovery of data and/or artifacts from historic or archaeological sites located by such a survey prior to authorization of a dredging project.

3. The Corps of Engineers, as directed by Executive Order 11593, has the clear responsibility to survey property under its jurisdiction and control to determine the presence of historical and archaeological resources, and to nominate to the National Register those which meet the criteria.

Response:
1. Either Section 106 or Executive Order 11593 require archaeological surveys to be made only if a proposed project would have an adverse impact on any archaeological resources. The Corps would make an investigation if a project was being considered in the area.

2. Has been noted in the final EIS.

3. The Corps recognizes its responsibilities under the provision of both Section 106 and Executive Order 11593 and will comply with the appropriate requirements. The Statement of Findings contains the intentions of the District Engineer to conduct a survey to locate and identify historical and archaeological resources within the project area or that would be adversely affected by O&M activities.

Comment (10): The statement apparently assumes that cessation of O&M of the locks and dams and channel for commercial waterborne transportation would automatically preclude O&M for any other purpose. In our view, this is not a fair assumption since it ignores the possibility of operating and maintaining such facilities for fish and wildlife and recreational purposes. Congress would have to change the primary objectives of the project in order to establish this alternative (as noted on page 336 of the EIS).

Congress is the governing body responsible for (a) authorizing the development of the 9-foot channel project, (b) authorizing public investments in the continued operation and maintenance of the projects, (c) establishment of the present Federal Fish and Wildlife Management objectives in the Upper Mississippi River Corridor, and (d) the establishment of procedures (under NEPA) for identifying, quantifying, and evaluating the environmental impacts and alternatives relative to major Federal actions significantly affecting the quality of the human environment, which is the purpose of the EIS.

Therefore, we believe that the authority and responsibility for considering whether or not it is reasonable to operate and maintain the present 9-foot channel navigation project for other public purposes belongs to Congress rather than to the Corps of Engineers. The Corps has a responsibility, in this case, to at least acknowledge the possibility of such a change in primary objectives, to quantify the alternative in a meaningful way which allows for independent evaluation by others, and to fully and objectively disclose any advantages and disadvantages applicable to such a potentiality. Such a discussion would likely reveal, for example, that most of the beneficial impacts of the project would be retained while most of the environmentally and socially adverse impacts would be substantially reduced or eliminated.

The draft statement properly acknowledges that the rate of sedimentation in backwater areas would be reduced by suspension of dredging. While some dredging would probably be necessary to maintain a safe channel for recreational boating, the volume of dredge spoil would be only a fraction, perhaps one-third, of the present amount since the channel would be maintained at substantially less than the present 300-foot width and 11- to 13-foot depth standards. This would result in either a net reduction in dredging costs or an opportunity to use more time-consuming spoil disposal methods that are less environmentally destructive than present methods, or both.

There would undoubtedly be less damage and wear and tear on lock structures than is now caused by the large, heavy barge tows. Overall, the environmental damages and system O&M costs would be substantially reduced. Such an alternative, though it may seem unrealistic under present Congressional policy, is reasonable for discussion purposes.

Response: Cessation of operation and maintenance of the 9-foot channel project would by definition result in cessation of funding to operate or maintain any of the structures for navigation. Such stoppage of funding would not preclude the appropriation of funds to utilize the Upper Mississippi River for other purposes, just as allocation of appropriations to continue current operation and maintenance activities on the 9-foot channel project do not preclude the appropriation of funds to provide for facilities for fish and wildlife and recreation facilities. Utilization of the river for other purposes and funding for such uses would depend on the relative merits of the use proposed. There are undoubtedly an infinite number of combinations of alternate use of the river system, not all of them necessarily desirable. In an attempt to remain within the meaning and intent of NEPA and CEQ guidelines, as well as Corps of Engineers regulations, and still provide the reader with an understandable and

meaningful discussion on the operation and maintenance activities of the 9-foot channel project and the reasonable alternatives, we have discussed briefly the alternatives which differ from those which do meet or only partially meet the primary authorized objectives of the project. We have discussed in greater detail those alternatives which retain the primary authorized objectives of the project. As was stated in the draft EIS, the impacts of the operation and maintenance activities of the 9-foot channel project are the subject of the EIS, and not the merits of the project nor the primary authorized objectives of the project, as they have already been judged prior to authorization.

Comment (6): We agree that fewer project-related beneficial impacts would be retained without O&M activities, but to assume that the locks and dams would be completedly removed as part of the "no project" considerations is not realistic or a proper basis for analysis (see page 272). Environmental impacts, especially in respect to O&M functions, should be made with the locks and dams in place.

Response: The "no project" consideration must realistically include removal of the locks and dams, since without operation and maintenance these structures would eventually become inoperable and cause increased safety hazards. Evaluation of an alternative that would allow the locks and dams to remain in place, but eliminate maintenance dredging would be yet another possible alternative to those considered in the Alternatives section of the EIS. This alternative could be considered comparable in magnitude to provision of a navigation channel of different depth than 9 feet.

Comment (18): Page 273, Top of Page - It could also be stated that the river bottoms would have fewer permanent shallow marsh and surface water areas, and that the sloughs would eventually fill in and not be as free running as before; however, time would repair some of this damage. Deer habitat would eventually improve, and deer, otter and raccoon would probably increase. On the other hand, mink,muskrat, and some fish species, such as carp and sheepshead, would decrease. American lotus beds would eventually decrease. The present feeding and resting habitat for most waterfowl would be diminished while wood duck nesting would increase. If the present public lands would remain in public ownership, some excellent wilderness values would eventually develop. However, the presence of the wing dams and closing structures would continue to channelize the river and eventually negate short-term improvements.

Response: Comment noted.

Comment (39): Page 273 further discusses that adverse aspect of towing operations, whereby barges are tied off to trees. Any careful analysis of fleeting or terminal operations would show that this practice has disappeared almost entirely. It is not permitted by the Corps of Engineers and almost every fleet in the St. Paul District now uses or is being converted to anchors or driven pile moorings.

Response: We concur that most of the barge fleets in the Twin Cities Metropolitan Area are being or have been converted to anchors or permanent moorings. However, the practice of tying barges to trees still exists within the St. Paul District. Field trips around the District, particularly in the more isolated areas, reveal scarred trees and occasional barges tied to trees. Many of the scars are fresh, indicating mooring at least in the recent past.

Comment (18): Page 273, Second Paragraph - An economic benefit which could accrue due to halting the operation and maintenance of the 9-foot channel would be a savings to the taxpayers. Railroads would probably experience an increase in traffic. Capital expenditures would be necessary to enable the railroads to service the increased transportation demand. This cost would be passed along to the consumer and diminish the effect of the decrease in Corps expenditures.

Response: Comment noted. The sentence "Economic savings to taxpayers would be realized as well as an increased demand for railroad services," was included at the end of the subject paragraph on page 185 of the final EIS.

Comment (18): Pages 274 to 283 - The comparison of the relative economies and fuel consumption rates between barge traffic and rail traffic appears to be somewhat slanted in favor of barge traffic. A factor which should be considered is that this information is based upon past experience. Over the past 30 to 40 years, barge navigation and air traffic have benefited from governmental subsidies. Meanwhile, the railroads have not been able to run at peak efficiency due to a general lack of capital which has led to a lack of investment in new equipment and more modern facilities. In addition, the analysis has not taken into account the true environmental costs of the past dredge spoil disposal procedure which has resulted in the deposition of material in areas that are susceptible to rapid erosion, in the filling in of wetlands and other environmentally sensitive areas, and in the general practice of spoil deposition in the floodplain which if allowed to continue for an extended period of time, could lead to economic losses due to increased flooding.

Response: An account of why railroads have not run with efficiency includes a long list of ills, some of which are the fault of Government regulation, but much of which is the fault of the rail industry itself. It should be recognized that railroads were founded on a bedrock of Government subsidy and are not without subsidy aids today (e.g.- grain movements by rail are subsidized during the winter months. This traffic would probably not move until spring and by water otherwise). The aggredation effect alleged in the last sentence is a problem which would persist with or without maintenance dredging. No significant additional threat from flooding is attributable to operation and maintenance of the 9-foot channel project. The true environmental cost is relative and can be alleviated by implementing other alternative methods of O&M which would have higher costs. The O&M costs, even if doubled from present costs, would probably not significantly reduce the large benefits which annually accrue to the project as it operates today.

Comment (12): Contrary to the overall theme of the EIS, energy and economic considerations should be developed recognizing the "no project" alternative as a viable one. This is especially important in view of the tremendous environmental impact of the project.

Response: Initial implementation of the project has impacted and changed the nature of the river environment significantly. These impacts and changes are described in the Environmental Setting section of the EIS. The impact of the operation and maintenance is fully assessed in the statement. Energy intensity while important to national policy, particularly after recent shortages, does not as yet clearly demonstrate a basis for a national policy of favoring either rail or barge due to the fuel conservation which might be obtained. However, the "no project" alternative is adequately discussed in the Alternatives section of the final EIS.

Comment (35): Page 274 - You may wish to consider the following for inclusion in the first paragraph - "in the case of coal, railroads are normally involved in the transportation from mines to loading docks where high utilization of equipment is attained due to single line control of cars."

Response: Comment noted. However, this suggested addition goes beyond the scope of this EIS and is considered extraneous information. Your information is appreciated but has not been added to the text.

Comment (18): Page 274, Second Paragraph - The statement is made that water carriers enjoy the advantage of lowest cost movement of bulk commodities for long distances. However, no information is provided on why this is the lowest cost alternative. Obviously, the subsidy being provided to water carriers in the form of current dredge spoil disposal and other maintenance practices without appropriate user costs has led to part of this advantage. It would seem appropriate that the impact statement should provide some cost estimates and reasons why user fees cannot be charged to barge traffic. If the taxpayer subsidy for navigation on the Mississippi River were removed, competition would develop and other transportation modes such as railroad and trucks might be more economically feasible.

Response: The public investment is less than the benefits derived. The lowest cost advantage would therefore exist no matter who would pay for the first cost investment (plus O&M). The question as to whether waterway users should repay the public costs to bring about these "net" benefits thus is separable from the lowest cost advantage. If all beneficiaries payed their fair share (including recreationists, fishermen, property owners, and commercial shippers), barges would continue to have the lowest cost advantage. The argument against or in favor of user fees, however, is not so simple. Theoretically, lower transportation costs are passed on to middlemen, consumers, and exporters. Again an argument or point of contention would exist here. Competition has already been fostered by waterway alternatives. Some would argue that even if no other benefits existed, the competitive constraint put upon railroads has paid for the investment in locks and dams already.

Comment (18): It is unclear whether the energy consumption by barge traffic takes into account that energy which is expended to maintain the navigation channel including energy required to operate the lock and dam system and energy required to dredge and clean out the channel on a continual basis. It is also not clear whether the energy intensiveness for waterway users includes all forms of navigation, such as ocean going vessels, vessels on the Great Lakes, and barge traffic on the Mississippi River. It would be assumed that the energy intensiveness of barge navigation on the Mississippi River would be higher than for other forms of navigation since the barges have to negotiate many bends in the river, have to oftentimes make double lockages, and at times have to wait for passing tows or for other tows to lock through. The inclusion of these factors in the economic calculations could cause an apparent cost differential between barge traffic and rail traffic to decrease or in some cases may actually reverse itself.

Response: Refer to "Barge Transportation and Energy Use" section which has been altered in the final EIS.

Comment (30): In the section entitled, "Barge Transportation and Energy Use," and subsequent sections extending from page 275 through 283, the statement explores the energy implications of shifting present barge traffic to rail transportation service. The discussion stems from and is essentially based on the energy intensiveness figures shown on page 276. The discussion accepts these figures at face value as given relationships representing the energy consumption of the various modes of transportation. In fact, however, analysis of the underlying data which was used to prepare the table on page 276 and the somewhat conflicting table on page 283 will indicate that both of these purport to be the energy consumption required in line-haul transportation service by the various modes. To the extent that additional pickup and delivery service is required in some transportation modes, the energy use for this service is not included in the table shown.

Response: The section "Barge Transportation and Energy Use" has been altered in the final EIS.

Comment (40): The draft EIS gives a very distorted energy consumption and air pollution comparison between the rail and barge modes.

Response: The section has been revised in the final EIS.

Comment (6): Present relative energy use studies by the Department of Transportation show that shipment by rail consumes less energy than shipment by barge (page 275). This data should be referenced and utilized. We suggest, too, that the study results on page 283 also be discussed in the Barge Transportation and Energy Use section.

Response: The section has been altered in the final EIS.

Comment (10, 6): Page 275 - Comments on the factors which "need to be considered in evaluating the present transportation system":

(Item d.) We question the assumption that railroads consume more energy than barge tows to move an equal volume an equal distance under all conditions.

(add Item g.) The possible effects of imposing user fees on waterway carriers to help defray O & M costs of the navigation project.

(add Item h.) The transit time and possible point-to-point delivery advantages of rail over barge.

(add Item i.) The comparative O & M impacts of the two modes on the natural resources of the nation.

Response: The section "Barge Transportation and Energy Use" has been altered in the final EIS.

Comment (18): Page 275, Item d. - The Rand Corporation found that the energy intensiveness for waterways was 500 BTUs per ton-mile while rail was 750 BTUs per ton-mile. On the other hand, information published in the "Railway Age" points out that rail traffic has an energy intensiveness of 536 to 791 BTUs per ton-mile and barge traffic has a energy intensiveness of 540 to 680 BTUs per ton-mile. Thus, since these data appear to conflict, we feel that this section should be deleted or clarified.

Response: The section has been modified for increased clarity in the final EIS.

Comment (34): BTU consumption by transport modes, as reported in the involved studies, is shown below:

TRANSPORT MODE	BTU PER TON MILE RAND	BTU PER TON MILE ORNL
Waterway	500	680
Railroad	750	670
Pipeline	1,850	450
Truck	2,400	2,800
Air Cargo	63,000	42,000

We find the ORNL factors for waterway and railroad to be correct. There are two significant errors in the Randy study:

1 - It did not account for duplications in traffic data reported by the Corps of Engineers on tonnage moving jointly on the inland waterways, Great Lakes and/or coastal/coastwise. This resulted in overestimating waterway ton-miles and underestimating BTU consumption per ton-mile.

2 - It did not subtract energy used for rail passenger service, which overestimated total fuel and BTU per ton-mile consumed for rail freight traffic.

There is a discrepancy in the waterway ton-mile statistics presented in Table 10, page 23, of the Rand study (see Exhibit I attached). In analyzing the Rand source documents, i.e., Statistical Abstract of the U.S. (Bureau of Census), and Inland Waterborne Commerce Statistics

(American Waterways Operators), we discovered the "Coastal and Coastwise" ton-miles for 1957 through 1968 included duplication of ton-miles reported under "Inland Waterways" on traffic that had movements on inland waterways and/or Great Lakes and coastal or coastwise.

We are concerned that the American Waterways Operators, in their annual publication of waterborne commerce statistics, would include ton-mile duplications, while specifically stating identical shipments over two or more waterways had been eliminated.

Attached are copies of documents that prove this point:

1 - Inland Waterborne Commerce Statistics, 1969 edition (American Waterways Operators), reports 175 billion ton-miles (BTM) for inland waterways, 107 BTM for Great Lakes and 310 BTM for coastal/coastwise; a total of 592 BTM for year 1967. (See Exhibits II and III.)

2 - Waterborne Commerce, Part 5, year 1967 (U.S. Corps of Engineers), reports 130 BTM - inland waterways, 75 BTM-Great Lakes and 310 BTM - coastal/coastwise; a total of 515 BTM. Thus, 77 BTM that were generated in coastal/coastwise movements were also counted in the inland waterways and Great Lakes traffic. (See Exhibit IV.)

3 - The problem of duplications in waterborne ton-miles is further clarified by the attached documents published in the October 1973 edition of Transportation Facts and Trends. (See Exhibits V and VI.) Using a total of 515 billion ton-miles and 337,145 billion BTU produces a revised year 1967 consumption factor of 655 BTU for waterway transport.

You probably are familiar with the Department of Transportation Report of September, 1973, entitled "Energy Statistics, A Supplement to the Summary of National Transportation Statistics," Report No. DOT-TSC-OST-73-34. This study accepts the Rand study BTU consumption factor only for truck and the ORNL factor for rail, water and pipeline, as indicated below:

ENERGY INTENSIVENESS BY FREIGHT TRANSPORT MODE

MODE	BTU/NET TON-MILE
Rail	670
Water	680
Oil Pipeline	450
Truck	2,400

Response: The section regarding "energy intensiveness" has been revised in the final EIS to more objectively represent the issues at hand.

Comment (10): Page 276 - Another notable example of "new problems since the 1930's controversy" is the recent increased emphasis on environmental protection, pollution control and social well-being.

Response: Comment noted. Subject sentence has been modified as follows: "Examples of the introduction of new problems since the 1930s controversy have been the recent increased emphasis on the effective use of energy, environmental protection, pollution control, and social well-being," on page 187 of the final EIS.

Comment (12): We agree with the EIS that energy consumption for transportation makes up a significant percentage of the total U.S. energy budget. However, in view of that fact and the magnitude of the present energy problem we feel that the treatment given this subject was proportionally inadequate to its importance. The subject of energy intensiveness needs to be developed more completely for waterways transportation and all other reasonable alternatives operating under similar circumstances of origin and destination, nature of cargo, etc. and serving the same geographic area.

Response: The section "Barge Transportation and Energy Use" has been altered in the final EIS.

Comment (30): The entire discussion assumes that BTU's per ton-mile is a legitimate means of comparing the energy intensiveness of the various modes of transportation. In fact, the statement assumes that this measure is the only measure of such energy intensiveness. Such an assumption is at the very least open to serious question. Comparisons of relative fuel consumption per ton-mile by mode of transport are not only irrelevant, and misleading, they are dangerous because they appear to be legitimate. Thus a statement that railroads can produce four times as much transportation per gallon of fuel than can trucks is impressive, especially so when it is uttered by no less an authority than the U.S. Secretary of Transportation. Properly analyzed, however, its fallacious nature is apparent. BTU consumption

per ton-mile for line haul transportation is a completely inadequate measure for determining energy efficiency of the various modes of transportation.

The Environmental Impact Statement is concerned only with the trade off between barge movement and rail for bulk commodities other than in a two-sentence statement on page 277. It is suggested that references to the energy intensiveness tables should be deleted. Alternatively, since the report is clearly directed to analysis of competition between barge lines and rail carriers, the discussion and figures cited might be limited to these two modes. If references to other modes are to be included, we submit that further documentation is necessary to justify the statements made in the first paragraph on page 277.

Response: The section "Barge Transportation and Energy Use" has been altered in the final EIS.

Comment (10): Page 276 - Because nature does not provide uniform conditions in all parts of the country, the argument that waterways inherently require less energy to move freight than any other mode is very much open to question. The final EIS should not use the Rand study cited in the draft for comparison of energy requirements for waterway movements on a "locking river." (The Rand study has since been updated, showing a less favorable ratio for waterways.) Even the "apparently conflicting" study from "Railway Age", cited on page 283, involved 17 railroads involving all kinds of freight at various speeds over all types of terrain. The only valid analysis for the Upper Mississippi River 9-foot channel project would be a comparison of energy consumption of movements on the Upper Mississippi with that of similar cargo movements by other modes under conditions typical of the Upper Mississippi region. It is recommended that such an approach be taken in the final EIS.

Response: A suggestion as to the updating of the Rand study has been included in the final EIS. Additional revisions have also been included in the Economics section of the final statement.

Comment (4): Page 276 - The information regarding the relative energy use of railroads and barge traffic presented on page 283 should be introduced and discussed in this section.

Response: The section "Barge Transportation and Energy Use" has been altered in the final EIS.

Comment (34): See draft, page 277 - "If the costs of energy rise sufficiently, increased capital necessitated by use of the slower moving barge transportation and increased capital tied-up in inventory and storage space may be justified." We disagree. Fuel expense for a 4,200 horsepower towboat currently represents approximately 36 percent of total annual operating cost (excluding depreciation and interest). Fuel expense for rail is approximately 7 percent of total annual operating cost (excluding depreciation, equipment and joint facility rents). Thus, it is apparent that increased fuel prices will have a much more adverse effect on barge operating costs, and resulting rates to shippers, than rail.

Response: The section "Barge Transportation and Energy Use" has been altered in the final EIS.

Comment (18): Page 277, First Paragraph - An attempt is made to show that the railroads could not possibly handle the additional load if barge traffic were to cease on the river. No attempt is made, however, to show what portion of this load the rail system could handle. It would seem appropriate that a portion of this section should include a complete analysis of the rail industry's capabilities and possibilities for handling the additional work load involved. This superficial analysis continues in the second paragraph of page 280 where the statement indicates that, with the current shortage of rail cars and the heavy demand for them, it is unlikely that manufacturers could provide any additional cars. It has been repeatedly stated that the same situation exists for barges. This would seem to indicate a lack of ability on the part of barges to handle the added projected work load.

Response: The attempt is to show the dependency of the region on barge in the short to intermediate time span. It is sufficient to show magnitudes involved. The reader can be the judge of how much the rail might handle when and at what cost. The capabilities of railroads and their shortcomings are fairly well known, particularly by shippers. The need for an assessment of railroad capabilities is not believed to be essential for an adequate evaluation of the "no project" alternative.

Comment (34): See draft page 277 - "The role of the Upper Mississippi River as a transportation artery is shown by the burden which would be placed on the rail system . . . in the absence of barge traffic on the river." We believe a proper investigation of the rail system in the Upper Mississippi River area will reveal there is adequate capacity to accommodate barge traffic from and to the St. Paul District

and other districts. Railroads, like barge and truck operators, do not purchase equipment for traffic that does not exist. In the absence of barge transportation in this region, there is no reason to believe the railroads would not have the capacity or wherewithal to handle the added traffic. In 1973 U. S. railroad capital spending was $1.35 billion, an increase of 11 percent over 1972. Expenditures for new equipment, cars and locomotives, totalled about $910 million and roadway improvements accounted for another $440 million. In addition to the railroad investment in rolling stock, another $500 million was spent by leasing companies and private car lines, including those which are railroad subsidiaries.

Response: The railroads have suffered a steady decrease in numbers of rolling stock for the past several years. The shortage of rail cars has become less and less just a seasonal and special situation problem. Railroads have argued that despite the decrease in numbers, better utilization has actually increased rail car availability. However, this argument has been rejected and the ICC has ordered railroads to repair and bring back into service rolling stock which has been idled. This is despite the statistics cited above. The "burden" placed upon railroads would be extreme in the short run (2 or 3 years), significant in the intermediate 3 to 6 years, and in long term would probably be minor. A shutdown of the waterway would be an intolerable economic situation for the region unless done over an extended period of time.

Comment (10): Page 277 - Since much of the rail shipment of coal and grain is being handled in 100-ton cars, now the "50-ton average" figure is too low; 75 tons-per-carload is more realistic. Thus, to move the estimated tonnage hauled on the 9-foot channel in the St. Paul District in 1972, it would theoretically take about 218,000 railroad carloads in 2,180 trains of 100 cars each, or something less than six trains daily for a year. If the cars and locomotives were available (we have not checked their availability), the existing railroad system in the Upper Mississippi valley region probably could handle the increase in traffic. The final EIS should comment on this capability.

Response: The referenced example regarding the "50-ton average" railroad car capacity has been revised in the final EIS. However, the short to intermediate capability of railroads to handle these sustained movements does not appear to exist. Certainly, the capability in the long run could be attained. However, no large amount of excess capacity exists for either modes, barge or rail. As stated by the railroad association elsewhere, neither rail or barge "purchase equipment for traffic that does not exist." The volume going by barge today represent "traffic that does not exist" to the railroads.

Comment (40): Statements on page 280 of the draft EIS present a distorted picture as to the number of railroad cars required since almost all of the Upper Mississippi River traffic involves grain or coal. For high volume movements of coal and grain, the railroads use unit trains consisting usually of 100 cars. Almost without exception, the hopper car capacity for unit trains is 100 net tons and the total net tons per train is usually 10,000 tons.

Response: Although unit trains with hopper car capacities of 100 net tons are used for movement of coal and grain, many hopper cars with capacities of 50 net tons are also used. Although a different net car capacity may be the actual accurate figure to use, the general purpose of the statement was to give an indication of the general magnitude of this impact.

Comment (6, 4): A section entitled "Barge Transportation and Water Pollution," following the section on air pollution, would add considerably to the statement. Such a new section should discuss barge related pollution such as barge loading and cleaning. In addition, regulations for prevention of accidents resulting from overloading or underpowered tows should be taken into account.

Response: We agree that such additional information would be desirable, but we feel it is not essential for an adequate understanding of the impacts of the operation and maintenance of the 9-foot channel project. Compilation and presentation of such information would be helpful to an overall understanding of the present setting along the river, and if readily available, could be included in possible future revisions or updatings to this EIS.

Comment (10): Pgge 278 - The final EIS should acknowledge that the "estimated savings in transportation costs (by waterway shipments) over the other various least-cost alternatives" are:

(a) made possible largely because historically waterway shippers have paid no tolls or fuel taxes to help maintain the system designed and built for their shipments;
(b) offset by the overall cost (first cost, O & M cost and replacement cost) of providing the waterway transportation system at taxpayer expense.
(c) based upon a study done to evaluate the economic feasibility of replacing locks and dam 26 of the Upper Mississippi River 9-foot channel project, but which handles traffic for both the Upper Mississippi and Illinois waterways. The final EIS should discuss the true cost of the system and estimate any savings resulting from waterway shipping in terms of dollars per year, both for the St. Paul District portion of the river, and for the Upper Mississippi River as a whole.

Response: The need is not apparent for the above suggested inclusions. The "true cost of the system" has not been evaluated nor have the estimated savings per year. Data are not readily available (due to the time period of 40 years involved). Variables are too plentiful to make quick dollar comparisons (e.g. rates in competition with barge are cheaper than would otherwise occur without competition; some seasonal tonnage moves on rail at subsidied rates, etc.).

Comment (34): See draft page 278 - "Among users of diesel engines, barging probably is more efficient than either rail or truck." (Refers to air pollution) This is an assumption that is not documented with fact. While rail locomotives and towboats primarily consume the same type fuel (No. 2 distillate fuel oil), barge miles on traffic to and from points on the Upper Mississippi River exceed rail miles by 29.1%. Thus, while a rail shipment would move say 1,000 miles, the equivalent barge movement would involve 1,291 miles. Consequently, rail transport is the lesser contributor to pollution. In 1972 the U. S. railroads spent $92 million to improve the environment. We anticipate the 1973 figure will greatly exceed this amount.

Response: The section "Barge Transportation and Energy Use" has been altered in the final EIS.

Comment (34): There is a significant factor that has not been considered in any of the energy intensiveness reports to date, and that is average BTU consumption per net ton-mile alone is not an accurate comparison between water and rail transportation. Water interests have been silent about inland barge and coastwise vessel mileage circuity over rail mileage between common points. As information, attached Exhibit VII compares barge versus rail miles from five representative origins on the Upper Mississippi River to eleven representative destinations on various waterway systems. These movements were selected from actual barge shipments reported in Part 5, Waterborne Commerce for 1972. (In some instances the actual movement was upbound in lieu of downbound.)

For the involved 55 movements, barge miles exceed rail miles by 29.1 percent. Utilizing the ORNL factor of 680 BTU for waterway, plus a mileage circuity factor of 29.1 percent, produces waterway consumption of 878 BTU per net ton-mile between barge and rail common points on movements involving the Upper Mississippi River as an origin or destination.

Very little barge tonnage originates and is consumed at river bank points; therefore, an additional BTU factor would have to be added to cover energy consumption on a substantial amount of water traffic that must move considerable distances either to or from the waterway. Such movements generally are by the least fuel-efficient surface transportation mode - truck.

In view of the foregoing, it would be proper to revise the EIS to reflect that fact that rail is more energy efficient than barge, or any other mode of surface transport.

Response: The section "Barge Transportation and Energy Use" has been altered in the final EIS.

Comment (26): The part up to "...pools on river barges" was in the consultants' reports, but I was unable to find the portion following that, after much looking. If the portion beginning with "Future expansion of the barging traffic ..." was not in those reports, the first sentence in the following paragraph should precede it.

Response: Subject sentence has been modified to indicate that the information was derived "in part" from the consultants' report.

Comment (36): Paragraph 2 on page 279 begins with a statement that the source of the previous paragraph was North Star Research Institute's environmental impact assessment reports. We believe that this is true for only the first part of the paragraph, that is, from its beginning on page 278 to the phrase "...or move through the St. Paul District pools on river barges." The text material which follows is not, as far as we can determine, in our reports. If it was, indeed, in one of our 14 reports, please inform us as to the pool report and page number. If it was not, we suggest it either be deleted or be moved below the reference to North Star's authorship.

Response: Refer to previous Comment/Response.

Comment (10): Page 279 - "Future expansion of the barging traffic," due to opening of strip mines for coal production in the west, is much more speculative than presented. The final EIS should deal with the subject only as "a possibility."

Response: The latest information is that western coal will move to three water terminals for transshipment by water; Duluth-Superior, the Minneapolis-St. Paul area, and the St. Louis area. Very large contracts for larger volume movements are just starting. The "possibility" now is a question of how much and for how long, not if.

Comment (10, 6): Pages 279-282 - Presentation of quotes from letters from waterway users which "will suggest the strength of their argument in favor of continued operation and maintenance of the 9-foot channel," is improper. Such communications seek to justify the continuation of

the major Federal action. They belong in the discussion on comments and warrant the same treatment as that which the Corps plans to give to the comments of any agency, organization or industry on the proposed action. Inclusion of such material within the draft proposed EIS text creates a serious imbalance in the statement.

Response: Presentation of quotes from waterway users tends to give the reader a better feel of the value the users of the river place on the waterway. Quotes from other interests have also been used at other points in the EIS. Inclusion of such material is believed to add to the readability of the report and is not believed to create a serious imbalance in the EIS.

Comment (18): Page 281, First and Third Paragraphs - It is indicated that towboats used to propel the barges draw eight to nine feet of water at optimum peak efficiences. It is also indicated elsewhere that squat can increase this depth another foot and a half and that the tows can only draw significantly less than eight feet if fuel and water are removed from the hull of the tows. As a result, there is no acceptable alternative to the 9-foot channel. Since Congress has only authorized a 9-foot channel, it is conceivable that only a 9-foot channel must be provided by law. It would seem that the barge companies are relying on the Corps to, in fact, over-dredge the channel so they can continue to operate in a more economical fashion. Thus, the Corps' continued practice of over-dredging has led to a system of navigation which now completely relies on over-dredging.

Response: Over-depth dredging is accomplished to preclude frequent reshoaling of problem areas which would cause unnecessary delays in navigation or disruptions to dredging schedules. Although a depth of greater than 9 feet is provided at the location after dredging, the 9-foot depth is the controlling depth for the channel. Barge companies as well as any other interest are allowed to use as much of the river depth as they desire, and they can expect to receive a channel depth of at least 9 feet throughout the entire length of the 9-foot channel project. To say that the system completely relies on over-dredging is not necessarily true, although it must be recognized that over-dredging is presently an important facet to maintenance of the 9-foot channel project and in keeping it available for navigation when needed.

Comment (40): With reference to the rail car shortages mentioned on pages 280 and 282 of the draft EIS, these shortages are usually seasonal in nature and of limited duration. Rail car shortages frequently

develop during the periods of heavy demand for moving grain. While storage represents an alternative to shipping of grain during the peak grain harvest period, shortage, of course, involves additional costs. A good answer to the periodic rail car shortages for moving grain would be the payment of an extra charge for the use of rail cars for moving grain during the grain harvest period. If more grain were put in storage, it would obviously level off the period of high demand for rail cars. There are enough rail cars; the real problem is merely better utilization. The railroads are not free to vary their rates in response to these high demand periods.

Response: Comment noted.

Comment (10): Page 283 - The "Railway Age" discussion of energy use in transportation is badly misplaced; it should have been presented alongside the Rand Corporation study findings on page 276 under "Barge Transportation and Energy Use" rather than as an afterthought under "Barge Transportation and Cost Savings."

Response: Concur. This section has been revised in the final EIS.

Comment (18): Page 283, First Paragraph - Rather than being a simple example of conflicting information, these points should have been clarified in the draft Environmental Impact Statement. On page 275, it is stated that the railroads require a greater consumption of energy to move an equal volume and equal distance compared to barge transportation. On page 278, it is stated that diesel trains produce 1.5 times as much air pollution as tugs and barges based on energy intensiveness ratios. With these conflicts in information and data, it is our position that neither of these statements can be made.

Response: The section "Barge Transportation and Energy Use" has been altered in the final EIS.

Comment (10): Page 283 - Discussion of "the inter-relations of projects.. in operation by any agency or organization" (Corps ER 1105-2-507, Appendix C, Sec. 4b), as it pertains to the obviously major function of the Bureau of Sport Fisheries and Wildlife's National Refuge, is very inadequate in this section. The statement should indicate how much of the 106,197 acres of land made available to the Bureau through the Corps' 9-foot channel project are lands submerged by waters of the navigation pools. On page 47, the statement is made that "a considerable portion of the 113,366 acres of federally-owned land in the various pools lies below normal pool levels." It should also be noted that the maintenance and patrolling of most Federal lands in the pools is handled by the Bureau of Sport Fisheries and Wildlife.

Response: It is hoped that the Habitat Inventory Study currently being funded by the Corps, and the results of which will be available to the Bureau of Sport Fisheries and Wildlife, can be used to define the amount of submerged acreage. The suggested note in reference to maintenance and patrolling has been included on page 195 of the final EIS.

Comment (10): Reference shuuld be made to the BSF & W's goals and policies for administration, zoning and management of refuge lands as set forth in the conceptual plan entitled "A Plan for Upper Mississippi River Wildlife and Fish Refuge" (September, 1968). Incidentally, the draft EIS heading incorrectly identifies this project as the "Upper Mississippi Fish and Wildlife Refuge." Also, the refuge is managed for wildlife and fish resources.

Response: Subject reference has been included in the sections "Relationship of the Proposed Action to Land Use Plans," and "Projects and Proposals of Other Agencies" of the final EIS.

Comment (6): This section (page 288) also should mention the Memorial Hardwood State Forest in southeastern Minnesota. It will ultimately consist of some 200,000 acres in eight counties, five of which are located along the Mississippi River. The establishment of this forest would have a direct relationship on the reduction of sediments in some of the tributaries of the Mississippi River. More information can be obtained from the Minnesota Department of Natural Resources.

Response: Subject information has been included on page 196 of the final EIS.

Comment (10): Page 284 - The section on the Great River Road should acknowledge that Congress authorized the appropriation of a total of $90 million "for construction or reconstruction of the Great River Road" in Section 148 of the Federal-Aid Highway Act of 1973. This represents yet another Congressional recognition of the values of the river corridor for public enjoyment of scenic beauty and for public use as a recreational resource.

Response: Concur. Subject information has been included in the discussion of the "Great River Road" on page 197 of the final EIS.

Comment (10): Page 285 - Since the title of the National Recreation Area bill is given, the much more useful reference, HR 11603, should also be cited.

Response: The subject reference has been included in the final EIS.

Comment (12): The EIS notes the need for cooperation and coordination of agencies, such as the U.S. Soil Conservation Service, the Bureau of Sport Fisheries and Wildlife, etc. as well as congressional authorization and funding as major impediments to enacting such programs as erosion and sediment control and selection of spoil sites with minimum adverse impact. We cite as an example conflict between a Bureau of Sport Fisheries and Wildlife proposal for a Upper Mississippi Wilderness Area and Corps operation and maintenance of the 9-foot channel and resultant heavy barge use. May we suggest that a project with such significant adverse environmental impacts, extra effort should be exerted toward achieving the needed cooperation, coordination, authorization and funding to enact programs which will mitigate these impacts wherever and whenever possible.

Response: Concur.

Comment (10): Page 289 - The discussion of the interrelationship between the O & M of the St. Paul and Rock Island Districts should be expanded to acknowledge that the maintenance dredging capability and practices (such as overdepth dredging to 13-foot depths) in the St. Paul District are influenced by the fact that the DREDGE THOMPSON is assigned to work in both districts. There should also be a simple description of the Rock Island District portion of the 9-foot channel project (number of pools, length in miles, annual tonnage, etc.).

Response: Reference to the responsibilities of the DREDGE THOMPSON to both districts has been adequately presented in the statement. Reference to a simple description of the Rock Island District has been included in the subsection "Projects and Proposals of Other Agencies" in Section 2 of the final EIS.

Comment (10): Page 289 - The final EIS should certainly include a discussion of the Lower St. Croix National Scenic Riverway as designated in the Lower St. Croix River Act of 1972 (PL 92-560). How this highly-publicized project of the Department of the Interior and the States of Wisconsin and Minnesota could have been overlooked in the preparation of the draft EIS is puzzling, especially since there is a direct interrelationship between it and the 9-foot channel

on the St. Croix River. A Master Plan is being prepared for the Scenic Riverway which includes the following recommendation: "A spoil disposal plan should be developed so that dredge spoil material from the 9-foot channel would be used to supplement existing beach areas or to establish additional recreation sites outside the floodway." It should also be noted that no new commercial or industrial development on the St. Croix River will be permitted unless it is deemed compatible with scenic preservation criteria and standards.

Response: Subject discussion has been included in the sections "Relationship of the Proposed Action to Land Use Plans" and "Projects and Proposals of Other Agencies" in Section 2 of the final EIS.

Comment (10): Page 289 - Since transportation by water is the main purpose of the project covered by this EIS, a discussion should be added of the St. Lawrence Seaway-Great Lakes water transportation route which is an international transportation system and also a major influence on the same region served by the 9-foot channel. It would seem that many of the same transportation characteristics attributed to waterway shipments on the Upper Mississippi River apply to Great Lakes shipping. Thus, a discussion of comparable factors, such as types of commodities, tonnages, and assumed economic advantages is needed to allow for a basic analysis of the interrelationship between the two waterways.

Response: Although the St. Lawrence Seaway-Great Lakes water transportation system has a major influence on the same general region of the Upper Midwest as does the 9-foot channel project, they do not serve the same areas in exactly the same ways. We do not believe that a discussion of the St. Lawrence Seaway-Great Lakes system would contribute substantially to the reader's understanding of the 9-foot channel project and its various aspects and impacts. If a comprehensive transportation study for the Upper Midwest were undertaken, such a comparison would be necessary.

ENVIRONMENTAL IMPACT OF OPERATION AND MAINTENANCE

Comment (17): An indepth analysis of this draft Environmental Impact Statement points out that the Corps is attempting to defend an ongoing program that is a clear antithesis of the congressional mandates and executive orders contained in Exhibit 227. To an uninformed observer, the present techniques and assumptions for analyzing the impacts attributed to the operation and maintenance of the 9-foot channel may not appear to be unreasonable. However, the result of this procedure is that the adverse impacts of the project are largely ignored while the benefits are overemphasized. The methodology used was to first analyze the impacts of operation and maintenance of the project, and then to superficially examine the impacts ascribed to the presence of the project. As a result, important adverse impacts, such as sedimentation, could be attributed to natural processes. It is our position that in order to arrive at the presently missing cause and effect relationships of the project it would be necessary to rigorously analyze the adverse and beneficial impacts due to the presence of the locks and dams first. This should then be followed by a complete and thoroughly documented assessment of the impacts attributed to the operation and maintenance of the project. It is our belief that this procedure would point up several cumulative adverse impacts, and would provide a clearer understanding of necessary remedial measures.

Response: The EIS addresses the operation and maintenance of the project and not the project itself. However, we felt it necessary to describe the effects of the existing project to set the stage for the existing setting. Although we have not gone into great detail on the effects of the existing project, we feel that sufficient information is presented to serve as a prelude to the impacts section of operation and maintenance of the project. We disagree that our analysis of the impacts of operation and maintenance of the project is superficial since it represents the results of all presently available information developed regarding the matter. At the present time the sedimentation issue is a most important unanswered question. However, regarding the adverse effects caused by natural sedimentation and those caused by dredging operations, the EIS does not try to minimize its importance or effects, but merely points out that until sedimentation data is collected we are unable to properly assess the cause and effect relationships involved. This EIS was prepared under current guidelines for preparation of environmental impact statements and is believed to meet these guidelines. The relative merits of Exhibit 227 of the draft EIS regarding the Complaint filed by the State of Wisconsin is a subject for the courts rather than this EIS.

Comment (24): A true assessment of the effects of the 9-foot channel on the Upper Mississippi River is incomplete unless the statement covers not just operation and maintenance since the project was constructed but also the effects of construction, particulary of impoundment.

Response: Refer to previous Comment/Response.

Comment (18): Page 295, First Paragraph - An attempt is being made to back away from any real effort at quantifying the adverse impacts of the channel maintenance program. The statement is made here and elsewhere that follows this basic line: adverse impacts such as the filling of guts of important sloughs, sedimentation of backwater areas and the blocking of flows to these important backwater areas is occurring. It is not known, however, how much of this problem is being contributed by dredge spoil disposal, although it probably does have some affect on these matters. One of the purposes of an impact statement is to define the specific adverse impacts of the project. This has not been done and as such it appears that the purpose and intent of the impact statement has not been realized. Cost estimates in this report are applied only to construction work itself and not to adverse impacts. As such, the Environmental Impact Statement does not give proper attention to a program that is best for the long-term public interest, taking into account all considerations, but arrives at the most economical way from the construction standpoint in which to perform maintenance dredging. An excellent manner by which to investigate whether dredge spoil disposal or "natural processes" are more significant in channelizing the river would be to remove the dredge spoil from the floodplain completely in order to see what happens. At any rate, continued dredge spoil disposal in the floodplain is certainly of no assistance in ameliorating this problem.

Response: Refer to the previous two Comment/Response regarding the adequacy of the discussion of impacts. The EIS does account for the environmental parameters associated with the various alternatives to the present operation and maintenance activities as described in the Alternatives section. Exhibits 194 to 208 of the draft EIS also presented the impacts and effects of the various alternatives on economic, social and environmental parameters. Removal of dredge spoil from the floodplain in order to "see what happens" would be a random approach to the problem and could result in a large waste of effort and time, and still not resolve the basic environmental issues at hand. In addition, the removal and deposition of spoil out of the floodplain would have associated environmental impacts. An assumption that such impacts would be entirely beneficial to man's environment would be illogical.

Comment (25): The premise and entire thrust of the statement is basically incorrect -- this is an environmental impact statement, not an economic impact statement. In this statement the environment is secondary while the reader is continually exposed to the Corps' rampant self-justifications supported by questionable economic analyses. A rosy economic picture is painted wherever there is the slightest nexus, and obscures the environmental considerations. We appreciate that the area's economy is heavily dependent on the channel, but everyone is dependent upon environmental quality.

Secondly, the environmental impact discussions are uniformly incomplete and evasive. The tendency is to attribute adverse impacts to anyone or anything but the Corps. Thus, we see turbidity being blamed on the catfish, and the considerable archeological site destruction blamed on farmers or labeled as "uncertain as to cause". Important tests which should have been included were not, so consequently no meaningful conclusions can be reached.

Response: Comment Noted.

Comment (20): The discussions of the impacts, in both the summary report and the pool reports, seems to be very general. There is not a clear identification of the positive and negative benefits. More importantly, there is no framework within which to judge the impacts nor are there any criteria for judging them. The general nature of the discussion makes it difficult to relate the impacts to specific areas, e.g., reaches within the Metropolitan Area.

Response: Although the specific impacts occurring within each particular reach of the river are not clearly identified in a tabular form or in discussion, the basic impacts which are related to the operation and maintenance activities for the project area are described. The more specific impacts for a particular reach can be developed by using: (1) Exhibits 31 through 42 to locate the disposal areas; (2) Exhibits 174 through 186 to determine the basic habitat conversions which occurred; (3) the descriptions of the habitat types provided in Section 2, Environmental Setting, to determine the value of the various habitats; and (4) the description of impacts provided in Section 4 of the final EIS, Environmental Impact of Operation and Maintenance, to determine the types of impacts to be expected based on the previous three factors. The use of other portions of the text and other exhibits will also aid to develop these specific impacts. As stated in the EIS, however, the degree and magnitude of the many of the impacts are not fully known at this time and further detailed study would be necessary to clearly set forth specific impacts.

Comment (1): It is noted that several wetland areas will be affected by the project. Our Wetland's Policy states that wetlands must be protected from adverse dredging and filling practices. Therefore, extreme care must be taken during O&M activities to avoid and minimize any adverse impact upon wetlands. Your new policy regarding the safeguard of wetlands as described in the April 3, 1974 Federal Register is highly desirable and consistent with our own views. With responsive and expedient implementation, such policy will substantially discourage the unnecessary alteration and destruction of wetlands considered to be environmentally vital to the riverine flowage. Although this policy is directed primarily toward the evaluation of permit applications, we fully realize the inherent responsibility to follow your own policy and our guidance as well as other agencies in wetland preservation.

Response: Concur. In the past it has been the Corps of Engineers' policy to protect wetlands to the maximum extent possible within the limits of our dredge plant capabilities.

Comment (1): It is evident from the EIS that there are many areas of uncertainty relative to project effects upon the river. Some occurrences are dismissed as "natural conditions" when in fact dredging operations may have an equal or even greater impact. Studies aimed at understanding the dynamics of the river segment involved would be beneficial in determining solutions to current problems. It is plainly evident that dredging operations as now practiced, certainly aggravate if not initiate many environmental problems. One significant area requiring further investigation is the relationship of dredging activities to backwater areas and sloughs, and the inherent fishery, wildlife and recreational opportunities that they offer.

Response: We concur that the above mentioned studies and others would be desirable to more fully understand the relationship between natural and cultural factors acting upon the river ecosystem.

Comment (1): The EIS should address the effects of St. Paul District's O&M activities upon the pools in the Rock Island District. The interface between the two districts and the impacts of operational procedures upon water quality and aquatic life should be thoroughly described in the EIS. The reasons for different operational procedures between the two districts to control storm or flood flows should be detailed and explained.

Response: The operation and maintenance activities in the St. Paul District would have very little impact on water quality or aquatic life in the Rock Island District, except in cases where operation of lock and dam 10 would have impacts on the upstream portion of pool 11

in the Rock Island District, where dredging in pool 10 would cause turbidity that might be carried into pool 11, or where scheduling of the DREDGE THOMPSON in the St..Paul District would affect the dredging schedule in the Rock Island District. These impacts are not considered to be significant and are not discussed in the final EIS.

The operational differences for the dams in controlling water levels in the St. Paul and Rock Island Districts stem primarily from which portion of the pool is kept at the most stable water level possible. The St. Paul District operation plan causes less water level fluctuations toward the middle portion and upstream end of the pool and required fewer real estate easements at the time of project construction. Project costs were reduced by using the operation plan of the St. Paul District. More detailed information on the specifics of operations at each lock and dam and water levels in each pool is available at the respective District offices.

Comment (6): Activities impinging on the trust lands of the Prairie Island Sioux Community raise the following important points of consideration: (1) The practice of depositing river spoil in the vicinity of several inlet channels to North Lake and Sturgeon Lake creates the potential for the introduction of this material into the waters of the lakes. The impact this might have upon the incidental fishing interests of the Prairie Island Sioux Community is an area of concern; and (2) Project activity impact as it affects the identification, protection, and preservation of archaeological and historical sites must be examined thoroughly.

Response: The specific effects of past operation and maintenance activities have been described in this EIS based on the information which is currently available. Studies to obtain additional information are being considered to more clearly identify some of the more specific impacts and their potential solution. Location of future dredge spoil sites will take into account the archaeological and historical aspects of potential disposal sites.

Comment (12, 18, 25): Secondary movement of dredge spoil compounds the existing siltation problems and leads to the smothering of aquatic vegetation in backwater areas. This is a significant adverse environmental impact inadequately quantified in the EIS. The EIS states that some 2,370 acres of dredge spoil can be measured from aerial photos. Most of these acres represent areas which were once backwater aquatic habitat. The EIS does not, however, attempt to break down the number of backwater acres of aquatic habitat which are only partially covered with spoil and have not as yet emerged as sterile sand islands which can be measured from aerial photos. Slope data presented in the EIS (10 horizontal to 1 vertical) seems to indicate that submerged dredge spoil deposition areas would constitute a significant portion of the total area affected. The final EIS should quantify the total area affected by dredge spoil deposition with due consideration of secondary movement of the spoil due to wind and water erosion.

Response: Although limited data on acreages of aquatic and terrestrial habitat is presented in the EIS, more complete and current data is not presently available. However, such information is in the process of being gathered by the Remote Sensing Institute, University of Minnesota, under a contract with the Corps of Engineers. At the present time, this work involves the type mapping and aerial measurement of the floodplain to include land use as well as various habitat types and dredge spoil disposal sites. The feasibility of utilizing remote sensing imagery to provide information regarding the submerged extent of dredge spoil disposal sites, secondary movement, if present, etc., is being investigated. The results of this work will be made available to interested parties.

Comment (18): Page 293, Second Paragraph, First Sentence - It should be stated that the dredge spoil circles are cut off in the vicinity of the main channel border because of erosion.

Response: Although in some cases erosion may affect the circular appearance of the spoil area, such is not the case as referenced on page 293 of the draft EIS. The referenced statement has been clarified in the final EIS.

Comment (6): The impacts of severe undercutting caused by erosion of the spoil along the main channel should be discussed. This could reduce the value of these undeveloped areas for recreation use.

Response: The comment presumably refers to excessive erosion of dredged spoil sites. Undercutting of shoreline, per se, refers to action resulting in an overhang which occurs along vegetated shorelines and is not a result of dredged spoil erosion. Subject discussion was added to page 227 of the final EIS.

Comment (17): A substantial ambiguity which leads to a contradiction is found on pages 293 and 305 of the draft EIS. On page 293, it is stated that "Approximately 2,370 acres of dredge spoil sites have been identified." And on page 305, it is stated that "It is not possible to accurately determine, on an acreage basis, the extent of river habitat affected by any one influence, such as disposal of maintenance dredge spoil."

Response: Although the statement on page 293 of the draft EIS indicates that approximately 2,370 acres of dredge spoil sites have been identified, it does not imply that this is the only acreage that has been impacted upon. And, as stated, the referenced sentence on page 305 is correct. The full relationship between the dredging and dredge spoil disposal activity, and its respective impacts on the riverine setting cannot be accurately determined with the presently available information. Additional information is being compiled to gain a more complete understanding of this relationship.

Comment (18): Page 294, First Sentence- Most of this sand would move down the main channel as bedload and would not enter side channels and backwaters if it were not dumped there by dredge spoil disposal practices.

Response: The 9-foot channel project has both positive and negative effects on the movement of bedload-type materials into side channels and backwater areas. For instance, wing dams and closing dams may reduce the quantity of coarse materials entering sloughs and infiltrating backwater areas. However, dredge spoil placed upstream of entrances to sloughs may erode and be redeposited in these entrances, hastening the degradation of the backwater areas. The net effect of these two contradictory influences has not been evaluated.

Comment (12): Secondary dredge spoil movement not only takes place in the backwaters but the common practice of non-confinement of dredge spoil accelerates the return of material back to the channels from which it was originally removed. An adequate evaluation of the economics of dredging demands quantification of (either by estimate or direct measurement the volume and cost of redredging. The necessity for redredging is a strong argument for on-land disposal of spoil. The fact that dredging and its immediate effects create the need for more dredging downstream should be addressed as a related impact in the final EIS.

Response: The quantity of material which is redredged and cost that can be attributed to the redredging of this material is not known and cannot be reasonably estimated at the present time. However, we believe, in general, that the social, economic, and environmental impacts associated with material that is redredged are minor compared to the direct and indirect impacts associated with material that is dredged for the first time. We have no documented evidence that dredging and its immediate effects create the need for more dredging downstream. If your agency has such information available, we would appreciate being made aware of it.

Comment (12): A study of annual oxygen profiles to determine the extent and duration of anaerobic conditions with associated nutrient releases from bottom sediments would be useful in determining the degree of eutrophication of the backwaters. This information would also be useful in determining the amount of fresh, oxygen rich river water necessary to these areas to prevent anaerobic conditions from arising.

Response: We agree that the above referenced studies and others would be useful in determining dissolved oxygen conditions in the backwater areas.

Comment (6): Significant adverse impact of O&M functions with respect to the geologic features of the area is not anticipated. However, the statement contains no discussion of the effects of dredge spoil upon the hydraulics of the waterway. The various alternates for disposal of spoil that were considered represent varying degrees of obstruction of the floodway. Their effects upon flood stages merit discussion.

Response: The effects of dredge spoil on the hydraulics of the waterway are discussed in page 298 of the draft EIS and also in the final EIS. The effects of the various alternatives, as presented in the Alternatives section on possible obstruction of the floodway was generally considered to be of similar proportions to that of the current methods and as such was generally felt to be insignificant. The alternative disposal sites evaluated were generally selected with consideration given to minimize any possible adverse effects of the dredge spoil area upon flood stages.

Comment (10, 12): Limitations of existing dredge equipment has periodically forced the Corps to disregard a general policy of avoiding the deposition of spoil in the ecologically fragile "gut" areas which provide for inlet of backwater "lakes" and is a significant factor in stagnation and eutrophication of these areas. Studies to quantify by core sampling and other scientific means, backwaters filling rates due to siltation, direct O&M spoil deposition, and secondary spoil movement are essential. Determination of nutrient budgets for some of the environmentally sensitive backwater areas are lacking in the draft EIS.

Response: Since the late 1950s it has been the Corps of Engineers' policy to avoid placing dredge spoil in ecologically sensitive areas such as "gut" entrances within the capabilities of existing equipment. During this time, the policy has never been "disregarded". However, there have been instances in the past where ecologically sensitive "guts" have been occluded with dredge spoil. These instances were discussed on page 297 of the draft EIS.

We agree that the above mentioned studies, among others, would be necessary to quantify natural and culturally induced sedimentation rates, and to more fully understand the bio-energetics of the ecologically sensitive backwater areas.

Comment (18): Page 295, Last Sentence - The stabilization of the hydrologic system and increased hydraulic efficiency of the main channel can be equated to a direct measurement of a reduction in backwater area, decreased water quality, and a reduction in general fish and wildlife habitat quality for the entire Mississippi River system.

Response: Your opinion is noted; however, we do not believe that the relationship which you have stated is necessarily true. Many other factors also enter into the "reductions in backwater area, decreases in water quality, and reduction in general fish and wildlife habitat quality for the entire Mississippi River," which you allude to.

Comment (12): The EIS makes a good case for the bedload trap efficiency of Lake Pepin; however, the 11 percent of the total sediment load that passes through Lake Pepin represents tons of fine sediment available for deposit in the backwaters below Lake Pepin annually. The impact, real or potential, should be detailed in the final EIS.

Response: Sediments fine enough to pass through Lake Pepin should cause little or no problems in either the navigation channel or backwater areas downstream since these sediments would be unlikely to encounter conditions more conducive to settling out.

Comment (18): Page 295, Second Paragraph, Second Sentence - We submit that large volumes of dredge spoil material have and continue to affect the backwater areas of the Weaver Bottoms rather than "small volumes of material can, and do, effect such large backwater areas as the Weaver Bottoms in pool 5."

Response: The text was intended to note that small volumes of material deposited by natural or artificial means at critical locations are able to affect very large backwater areas.

Comment (18): Page 297, Third Paragraph - While it is true that the flow patterns are being modified as the main channel becomes increasingly efficient, the ultimate conclusion is that the most engineeringly efficient channel would be one that would fill in all side channel areas and provide a straight channel from Minneapolis to New Orleans while providing capacity to handle the regional flood flow. Also in this paragraph, it is stated that the elimination of flow in backwater areas is caused by roadway construction, natural sedimentation, encroachment in the floodplain, or the

disposal of maintenance dredge spoil. However, no quantification is provided on how much this particular channel maintenance project contributes to this problem. In the last sentence of this paragraph, it is indicated that it is a practice to avoid placing material in the feeder channels of backwater areas; however, this has occurred in the past. Unfortunately, the cumulative nature of dredge spoil disposal and the movement of dredge spoil materials have had the net effect of depositing dredge spoil materials in these areas anyway. Since 2,600 additional acres of habitat must be used in the future for the status quo alternative, it will become increasingly difficult if not impossible to avoid such areas using present dredge spoil disposal methods.

Response: We agree that it will become increasingly difficult to avoid placing dredge spoil in the feeder channels of backwater areas, however, increases in dredge plant capability have been programmed for future year budgets to reduce this potential. Although dredge spoil has been placed directly in some feeder channels to backwater areas on occasion, these placements were not intentional, but were due to operational oversights. The common practice is to avoid placement of dredge spoil in such areas. The total extent to which these backwater areas have been or are being obstructed by dredge spoil is not known.

Comment (17): On page 295, there is a contradiction to the effect that "Since spoil deposition directly in such slough entrances is avoided, it is most probable that where dredge spoil is implicated in such problems, it is through erosion and subsequent redeposition of dredge material." On page 297, exactly two pages later, an admission is made that "Although dredge spoil has been inadvertently placed in the entrances ("guts") of feeder channels for backwaters in isolated cases, the general practice in placement of dredge spoil is to avoid such areas."

Response: The above referenced statement from page 297 is correct. It was not the intent of the statement from page 295 to imply that dredge spoil had never been placed in ecologically sensitive areas such as slough entrances, but that it was Corps policy to avoid such areas as much as possible within the capabilities of present equipment. The final EIS has been revised to present this idea more clearly.

Comment (17): Another major inadequacy of the draft Environmental Impact Statement is the paucity of consideration given to compatibilty of the operation and maintenance of the 9-foot channel with the State's statutory responsibilities and authorities. The Department of Natural Resources administers several regulatory functions under the Wisconsin Statutes including bulkhead lines (Section 30.11, Wisconsin Statutes); dredging (Section 30.20, Wisconsin Statutes); enlargements of waterways (Section 30.19, Wisconsin Statutes); fills or structures below the ordinary high watermark (Section 30.12, Wisconsin Statutes); and water pollution functions under Chapter 144, Wisconsin Statutes. The present practice of indiscriminate dumping of dredge spoil materials by the Corps of Engineers in wetlands, in navigable waters and on valuable upland habitat without any consideration for erosion protection or containment is difficult to justify to the private individual seeking a permit for the same type of authority. The same type of conflict arises in the administration of the State Flood Plain and Shoreland Zoning Rules contained in Wisconsin Administrative Codes, NR 115 and 116. Executive Order 11296 states "The heads of the executive agencies shall provide leadership in encouraging a broad and unified effort to prevent uneconomic uses and development of the Nation's flood plains and, in particular, to lessen the risk of flood losses in connection with Federal lands and installations and federally financed or supported improvements." In Flood Hazard Evaluation Guidelines for Federal Executive Agencies (1972) prepared by the United States Water Resources Council, it is stated that "It should be recognized that flood plains have unique and significant public values, including wildlife habitat of recreational, aesthetic and scientific value, open space, and ground water recharge. The value of the flood plain as an environmental resource and the public benefits to be derived from it should be considered." It is further stated in these guidelines that "In carrying out the responsibilities under Executive Order 11296, the Federal Executive Agencies should: Determine whether there are existing laws or statutes of the federal government, rules or regulations of other federal agencies, or laws, statutes, ordinances, etc., of state or local governments that provide standards for regulation of the flood plain under study. In cases where those standards are either more stringent than those based on these guidelines, or are applicable to situations or conditions not covered by these guidelines, they should be considered for evaluation of flood hazard in that area. By "more stringent" is meant a standard that is more severe or restrictive in order to provide greater

safety or to reduce flood hazard more effectively. Federal agencies should support the States and local governments to make their rules, regulations, standards, etc., fully effective." In reviewing the draft Environmental Impact Statement, only one brief reference with respect to placement of dredge spoil in the floodway could be found where it was stated on page 298 that "The operation and maintenance activities do not cause either significant increases in flood stages or greater flood frequency than would be the case without navigation improvements." Since the Corps of Engineers also administers regulatory permits for dredging and fills below the ordinary high watermark and flood plain use, we feel that it is important to discuss what controls for preventing fish and wildlife habitat losses and environmental pollution are imposed upon private applicants which are not also applied to the operation and maintenance of the 9-foot channel.

Response: The operation and maintenance of the 9-foot channel project is done in accordance with Federal laws, regulations, and guidelines. Full consideration is given to respective State laws whenever and wherever possible and to the maximum practical extent, the respective State laws are complied with. However, if full compliance with a State's law significantly infringes upon the ability of the Corps of Engineers to properly operate and maintain the 9-foot navigation channel, the necessary work is completed with due regard for, but not necessarily in full compliance with, the respective State law. The Corps maintains and operates the 9-foot channel project for the benefit of the entire public, and not just for the interests of one State. The validity and enforcement of any respective State law is a function of the relative merits of the law and the type of policy used to enforce the law. Whether or not the Federal Government is in compliance with a State law does not necessarily judge on the merits of that law and should not make it any more difficult to enforce.

The private applicants for dredging must comply with respective State, and Federal laws. As such, private dredgers in different States may be required to implement certain measures in their dredging that is not used in the operation and maintenance of the 9-foot channel. This might include confinement of dredge spoils.

Although the referenced subject matter has merit to the understanding of the relationship between State laws and the private dredging operations within the State, we do not believe that this information is critical to the understanding of the impacts and effects of the operation and maintenance of the 9-foot navigation channel.

Comment (28, 11): Page 298, Paragraph 1 - "Studies in this regard; however, are inconclusive at the present time, and the degree to which eroded spoil material is involved in the blockage of sloughs is not known."

From data given in the Environmental Impact Statement, as well as concern expressed by other agencies and individuals in regard to spoil effects on backwater recreation and wildlife habitat, it would seem appropriate that further information be gathered and evaluated to determine the impact of spoil placement on backwater sloughs. It would be difficult to cite the Environmental Impact Statement as being complete until further data and evaluation is recorded on this phenomena. While affect of dredge spoil placement on main channel waters has been adequately documented, the Environmental Impact Statement does not sufficiently detail the impact on backwater flowage and subsequent aquatic vegetation and submerged faunal activity. Man-made versus natural sediment deposition is not deliniated sufficiently, and the intent of the Environmental Impact Statement should not be considered as fulfilled until such determinations can be made.

Response: The information presented in this EIS represents all known available information on the referenced subject at the present time. Additional information, including data collection, must be obtained before more conclusive statements can be made. The Statement of Findings accompanying the EIS indicates areas where additional information is needed. Obtaining this information will take several years. We believe that this EIS is complete based on the information available. As more information is made available or conditions change such that an up-dated or revised EIS is necessary, one will be prepared.

Comment (18): Page 298, First Paragraph, Last Sentence - We would like to know why data regarding the erosion of dredge spoil material and its implication in the blockage of sloughs is inconclusive at the present time and why additional studies have not been proposed?

Response: Refer to previous Comment/Response.

Comment (18): Page 298, Second Paragraph - The statement that people have indicated that placement of dredge spoil is resulting in increased flood stages and that hydrologic studies by the Corps have indicated that increases in the Mississippi River profile due to

sedimentation from Corps dredge spoil disposal is expected to be very small, is not an adequate treatment of the full effect of dredge spoil disposal in a floodplain. While we would agree that an analysis on a spot by spot basis of any one particular spoil site would probably not show any significant increase in the flood stage at that location, the cumulative effect of the channelization from continuous spoiling that restricts the flood flow and stops the flood water from spreading through backwater areas and over the entire floodplain, when analyzed on a reach and double encroachment basis which is required under Wisconsin Law, would certainly indicate an increase in flood stages. This practice of filling hundreds of acres in the floodway with dredge spoil material strikes against the very concept of good floodplain management and land use practices. The fact that this is being done by the Corps of Engineers, who are responsible in part for floodplain regulations on the Federal level, makes it impossible to enforce similar regulations in the private sector. This practice of dredge spoil disposal in the floodway is in direct conflict with the Water Resources Council's recommendations and with the Federal Executive Order 11296.

Response: The referenced statement has been revised in the final EIS on page 209. Although the floodway limits in most areas of the river where dredging is accomplished have not yet been established, it is felt that any increases in flood stage which occur as a result of dredge spoil placement are generally in very localized areas and are not of significant magnitude. Areas where these localized increases occur would have to be evaluated more fully to determine the exact magnitude of the impact. If the magnitude of increase in flood stages due to dredge spoil deposition is more significant than currently indicated, additional consideration would have to be given to this matter in regard to future dredging operations. The Water Resources Council's recommendations and Federal Executive Order 11296 are not in direct conflict with current dredge spoil disposal practices. These documents refer to evaluation of flood hazards and wise use of floodplain lands with an aim to reduce flood damage to properties having a high degree of flood damage potential. The current use of dredge spoil areas is consistent with these documents and no significant increase in flood damage potential is believed to exist due to the location of dredge spoil areas.

Comment (11): Paragraph 2, 6th sentence - If dredge spoils are placed in the floodway, their placement would increase the flood stage. The States of Minnesota and Wisconsin have been working on defining the floodway in the area of discussion. When agreement is reached as to the location of this floodway, dumping in it may be in conflict with state floodplain laws.

Response: Refer to the previous Comment/Response.

Comments (6): Excessive discussion of only vaguely related topics is used to fill the void of sound data. For instance, the inclusion of the bath tub analogy of how the pools operate during flood periods in Section 3, Environmental Impact of Operation and Maintenance, is a prime example of unnecessary verbage. This explanation is adequately discussed in the Detailed Description of Operation section.

Response: Comment noted.

Comment (6): The statement adequately describes the value of aeration structures (page 300), but does not show the relationship to navigation and O&M functions. Incidentally, the notches and culverts appear to have been a part of the project as written in this statement. It should be mentioned that these features were constructed out of O&M funds at the request of the Bureau of Sport Fisheries and Wildlife and under the authority of correcting project "deficiencies."

Response: It was not the intent of the draft EIS to imply that the aeration structures were constructed as part of the original project. In the final EIS, on page 212, the following sentence has been added to the above referenced paragraph:

> "All of the aeration structures were constructed out of operations and maintenance funds under the authority of correcting project deficiencies."

Comment (18): Page 300, First Paragraph, Third Sentence - It should be stated that the periodic fishkills in the backwaters below the dikes and spillways is a result of improper engineering design on the original project and are more intended to correct original deficiencies in design. Additional impacts on water quality which were not considered include: pollutants from bilge water, oil spills and other material spills, and prop wash from barges (aerial photos taken by this Department in the summer of 1973, indicate that turbidity extends downstream from barges for a length of a mile or more). A significant

effect of the operation and maintenance of the 9-foot channel which has not been considered is the effect of dredge spoil disposal, erosion, and subsequent redeposition of dredge spoil material in the cutting off of backwater areas and the subsequent eutrophication and stagnation.

Response: Refer to the previous Comment/Response. Discussions of the possible water quality impacts mentioned above are included in Sections 4 and 5 of the final EIS.

Comment (6): The impacts on water quality from maintenance activities on the locks and dams require consideration. The problem of pollution from refinishing and repainting as well as runoff from machinery maintenance and road work on the lock property should be discussed.

Response: The volume of painting is very small. When using a brush, very little, if any, paint gets into the river. Sandblasting and spray painting is done primarily during a lock dewatering. With the new durable vinyl paints, the repainting occurs less frequently. Very little, if any, road work is done with the exception of seal coating at 7- or 8-year intervals. The road areas at the locks are very small in comparison to paved roads along the river. Petroleum storage tanks are diked.

Comment (6): The discussion of actual impacts on fish and wildlife and their human uses is lacking in depth and understanding. The subsection, Impacts of Dredging on Water Quality, discusses only local disturbances of short duration. Although the statement recognizes that a significant reduction of organisms occurs near the spoil site, it does not discuss the important secondary impacts of these losses. For example, a variety of fish and wildlife depend heavily on the organisms produced in these areas and the resultant loss or lowering of total productivity is not evaluated in respect to the resources. Such losses are meaningful, especially when speaking in terms of spawning and nesting success of fish and wildlife.

Response: We recognized that the placement of dredge spoil has secondary impacts to fish and wildlife and their human uses. We also recognize that volumes of narrative could be written on this subject and still not meet the satisfaction of everyone reading this Environmental Impact Statement. Throughout the draft EIS we attempted to simplify whenever possible in order that the narrative be understandable to the lay reader. We believe that the subject of secondary impacts which may result from dredge spoil disposal has been adequately implied within the text of the draft EIS. However, for the purpose of further clarification, the subsection dealing with

impacts of channel maintenance has been revised in the final EIS.

Comment (12): The EIS notes that a derrickbarge is used for maintenance dredging on the Minnesota River. No extensive details are given regarding water quality impacts of these specific operations and additional information should be provided in the final statement. The full downstream extent and impact of increased turbidity from both derrick and hydraulic dredging needs to be developed in much greater detail. The derrickbarge, from the description given in the EIS, operates in a manner which is unacceptable with regard to established MPCA regulations and/or guidelines. The derrickbarge is said to collect spoil material and then deposit the spoil along shore in at least 6 feet of water where deposition is made on land "if required."

Response: Additional information regarding the water quality aspects of both the derrickbarge and the hydraulic dredge would be desireable, however, none is available for inclusion in the final EIS. Additional information regarding these water quality aspects should be available some time after submission of the final EIS. Refer to attached Statement of Findings with regard to the District Engineer's recommendations on the findings of the EIS. If the EIS is revised or updated, additional water quality information could be added at that time as appropriate.

Full consideration is given to comply with State regulations to the maximum degree practical, however, in some cases it may not be feasible to fully comply with all State regulations. Further coordination is currently underway with MPCA to more clearly establish some of the issues at hand.

Comments (4, 18): Page 301, Impacts of Dredging on Water Quality - It is not stated what methods were used for determining the effect of dredge spoil disposal on water quality; for instance, were Standard Methods used? The U. S. Environmental Protection Agency has prepared a handbook for evaluating the quality of bottom sediments. The particular study that was done on pool 8 does not appear to have followed the EPA methods for analysis of sediment materials. Additional information on the dredge spoil study at Crosby Slough and Island should be included in this section. This information should include, but not be limited to, methods and equipment used to collect samples, methods used in analysis of samples, number of

samples taken at each station, location of stations, and dates and times of sampling. The question of whether climatic conditions, such as wind and rain were similar prior to each sampling date, should be addressed.

Response: The water quality techniques employed during the study at Crosby Slough were those described in the 13th edition of the Standard Methods. Samples were collected with a Kemmerer bottle. All samples were analyzed within 1 hour after collection. Benthic samples were collected with a Petersen Dredge in sandy areas, and with an Eckman Dredge in areas where soft sediments prevailed. Rainfall patterns did not appear to significantly affect the data. The microbiological data in the assessment report support this conclusion. Wind action on the site was not significant. Field notes indicate that no winds occurred above 15 knots during the tenure of this portion of the study.

Comment (12): Routine dredge and spoil deposition by the Corps has had an adverse impact on water quality of the river. Accelerated industrial development associated with increased navigation, increased oil spills and waste dumping associated with barge activity, also has had an adverse effect on river water quality. The frequency and magnitude of such spills is treated in a rather cursory fashion and should be expanded in the final EIS. A discussion should include the short term visible, as well as long term toxic effects. These are important impacts of barge shipment of such materials and the industrial development of the Upper Mississippi floodplain which are dependent on the operation and maintenance of the 9-foot channel.

Response: We believe that industrial development and oil spills, etc., are secondary impacts attributable to the 9-foot channel project and as such are discussed in the Environmental Setting under the subsection "Summary of Major Benificial and Adverse Impacts of the 9-foot Channel Project."

Comment (12): Exhibit 187 of the EIS gives average values and results of statistical tests of significance for water quality data before, during and after dredging and is based on information obtained in pool 8 in 1973. This table, which is used as a reference when making certain conclusions regarding general water quality, contains no other water quality data from any other pools, and fails to recognize important variables such as diurnal changes or meterological data, and has limited applicability to any other pools.

Response: We agree that the conclusions which can be drawn from the water quality data presented in Exhibit 187 of the draft EIS have limited applicability to the general water quality condition within the St. Paul District 9-foot navigation channel. Appropriate revisions have been made in the final EIS.

Comment (12): Page 301, Third Paragraph - We wonder why aeration facilities were not installed at lock and dam 9 according to the recommendations of the Bureau of Sport Fisheries and Wildlife?

Response: Refer to the following Comment/Response.

Comment (32): Page 301 - In addition to dams 4, 6, 7, and 8 aeration facilities were also constructed in dam 9.

Response: As was indicated on page 37 of the draft EIS, aeration facilities were constructed in lock and dam 9 in May 1970. This information was accidently omitted on page 301 of the draft EIS.

Comment (1): The data in Exhibit 187 regarding impact on water quality demonstrates some unusual occurrences which require clarification. Although the turbidity value for one week after dredging is explained as being in error, there is a significant increase in conductivity which might support the elevated turbidity value. Could the increase in these two parameters be caused by runoff from the disposal site and/or re-entry of sediments into the river?

Response: The increase in conductivity was not significant in the pool 8 assessment report.

Comment (1): The data in the Exhibit 187 also indicates that phosphate levels decreased during dredging. This seems highly improbable, especially in view of the nitrogen increase and the dissolved oxygen decrease. Was the reading, taken four days prior to dredging, a valid value? The persistence of the low dissolved oxygen value after dredging should be explained. Lower values for dissolved oxygen, and higher values for nitrates, conductivity and turbidity could be due to a sloughing effect from the spoil area. Existing programs for pumping spoil to disposal sites and returning the overflow to the river usually cause adverse local water quality impacts. These impacts can be mitigated with partial treatment of the returning overflow, i.e., dikes, successive ponding, and retention basins. Selective monitoring for changes in water quality in areas of spoil disposal should be initiated whenever maintenance activities have the potential to adversely affect water quality in locally important

recreational areas, ecosensitive wetlands, such as spawning grounds or waterfowl habitats, and water intakes for private, municipal, industrial or Federal use. If state water quality standards are violated, the implementation of appropriate pollution abatement measures will be required in accordance with the provisions of Section 313 of PL 92-500 and Executive Order 11752.

Response: The statistical data indicate no significant changes in phosphate and conductivity during the experiment. Dissolved oxygen value changes were attributed to diel responses. Section 313 of the 1972 Water Pollution Control Act (PL 92-500) requires Federal agencies to comply with State and local water quality laws. However, Section 511 of the same statute notes that the statute is not to be construed as impairing the Secretary of the Army's right to maintain navigation. Monitoring of water quality aspects of the dredging operation is commencing in coordination with EPA and MPCA, and pending results of the findings, appropriate action will be taken. Also refer to the Statement of Findings regarding the subject monitoring program.

Comment (6): The discussion of the impacts on water quality that were investigated near Crosby Slough needs expanding. For example, how long is the "relatively short period of time" referred to on page 303 for water quality parameters to return to predredging status? What are the differences between areas frequently dredged and those dredged only once? What changes in depth have occurred downstream?

Response: The term "relatively short period of time" was that used by the author of the pool 8 report. This interpretation referred to "a period of time" measured in days. In his judgement, the channel area dredged had returned to a normal state within 1 week after dredging (with regard only to turbidity due to the cutterhead activity). This statement does not include the spoil site phenomena. That is, instability on the spoil site does not become stabilized in this period of time.

Comment (18): Page 303, Second Paragraph, Second Sentence - It should be clarified that a spoil material eroded by wind and water affects areas far away from as well as close to the spoil site.

Response: The referenced sentence has been revised in the final EIS on page 213 to reflect this information.

Comment (12): On page 303 the EIS has identified autochthonous sources, such as leaves, as being the contributor of nitrogenous nutrients to the river water. Little consideration is given to the autochthonous sources involving the dredge spoil itself. While the leaves and the resulting leaching of organics may be a source of nitrogen, it is highly improbable that the leaves are the sole source of nitrogen and other nutrients.

Response: It must be remembered that the material actually being dredged is almost pure sand. Nitrogen levels in these sediments are practically non-existent. It is highly improbable that the actual dredged material can account for any significant source of

nitrogen. Leaves are indeed, not the sole source of nitrogenous material. Autochthonous cycles do occur in the navigation pools, but only in the lentic areas. Releases of these nutrients into the river channel occur during the annual cycle. However, due to the hydraulic efficiency of the channel, they do not reservoir in the channel areas, and consequently cannot be accounted for as having come from the dredged sediments at Crosby Slough.

Comment (28): This section implies that ownership by the Federal Government and the 9-foot channel project are coterminious; being one and the same. The Environmental Impact Statement attempts to cite a "cause and effect" relationship in that the 9-foot channel provides the basis for 1) effective flood plain zoning; 2) dependable public access and recreation facility provision; and 3) "more efficient management of fish and wildlife resources."

In reality, effective floodplain zoning is a mandatory county activity in Minnesota, and is mandatory for increased flood insurance benefits on a nationwide scale. Where it is not such, there is validity in the statement, but it should be noted that where Federal ownership does affect land use and zoning, it is through the presence of the Bureau of Sport Fisheries and Wildlife as well as the Corps of Engineers. In fact items b and c, under Impacts on Land Use, are more attributable to USFWS designation than to the Corps of Engineers. Thus Federal ownership should be noted as that of more than one agency, and the "cause and effect" relationship of the 9-foot channel providing cited benefits should be clarified.

Response: The land use plan indicated in the Mississippi River recreation master plan was the result of the combined effects of both the Corps of Engineers and the Bureau of Sports Fisheries and Wildlife. Recently the Bureau of Sports Fisheries and Wildlife has reduced its emphasis on recreation unless it is wildlife oriented. This leaves the Corps as the only agency to continue the responsibility for recreation development and management. The BSFW is responsible for wildlife management in the refuge, but without the Corps land, which the BSFW manages, the refuge would be considerably smaller and as a result would not be as valuable for the purposes for which it was created. With Federal ownership there is positive control of the floodplain, with non-Federal ownership the zoning could be changed to suit the local government.

Comment (18): Page 304, Impacts on Land Use - The implication that the Corps' creation of additional land in the middle of the floodway would be beneficial provided that local municipalities or States then effectively zone this area to inhibit development of homes and businesses in flood prone areas is not adequate. The program of floodplain zoning is made more difficult by the Corps' creation of lands which people may then wish to utilize.

Response: The referenced section does not refer nor make any implications with regards to the "creation" of land. The "larger unit" discussed refers to the large amounts of land placed in the ownership of the Federal government with implementation of the 9-foot channel project, and the resulting advantages in managing the uses of this land. However, the "creation" of land due to dredge spoil disposal practices does not make floodplain zoning more difficult, since State permits must be granted prior to any floodplain construction. The flood hazard of an area for development should govern the land use of the area. Dredge spoil is placed on private lands only after the private land owner has obtained the necessary permits.

Comments (4, 6): Page 305 - 307 - The use of 1940 maps to determine the habitats before disposal is inappropriate and fails to consider the approximately 25 million cubic yards of dredging spoil deposited prior to 1940 (Exhibit 76). This spoil volume is about 1/3 of the total spoil removed from the project to date. Secondly, the use of 1973 aerial photographs to identify present acreages of spoil fails to consider the erosion of some spoil areas, as well as the slight revegetation of others. Thus, the actual areas affected by spoil deposition are probably not adequately represented in the 1973 aerial photographs.

Response: The Environmental Impact Statement is directed toward the operation and maintenance of the 9-foot navigation channel rather than the construction activities associated with the project. Since the vast majority of dredge spoil deposition, which took place prior to 1940, was a result of project construction, this date is considered appropriate as a baseline for the evaluation of maintenance dredging effects. Regarding the use of 1973 imagery, the Remote Sensing Laboratory of the University of Minnesota is presently performing under contract a state of the art interpretation which will eventually include virtually all remote sensing imagery available from 1939 to the present. Although it is doubtful that even this analysis will delineate the quantitative degree of erosion which has and is taking place, when the data generated by this study becomes available, it will be utilized to revise and update the final EIS if necessary.

Comment (6): A reference is made to the direct loss of 1,300 acres of aquatic habitat, but again this is based on estimates arrived at by comparing 1940 maps and 1973 aerial photographs. The 1,300 acres actually represents only the visible portion of the spoil sites. The total area affected obviously is much larger. For each visible acre of spoil in aquatic habitat, we believe that more than 1 acre

of fish producing and feeding area is lost directly and many acres of habitat are degraded. In addition, the productivity of aquatic furbearers is reduced and less food producing area is available for waterfowl. The resultant impact of these losses directly affects human use of these resources.

Response: We agree with the first two sentences of the above comment. Refer to the previous Comment/Response. The opinion stated in the remainder of the above comment is noted.

Comment (10): The statement that "The spoil frequently spreads out into off-channel areas affecting several types of shallow aquatic habitats such as marshes, floodplain lakes and ponds," is so significant that it should be included in the Summary section of the final EIS.

Response: The statement has been included in the Summary section.

Comment (18): Page 306, Fourth Paragraph - It is indicated that 2,370 acres of spoil sites have been identified which constitutes about 1.4 percent of the surface water area of all the pools. This acreage would be much larger since the spoil that was underwater and the spoil which was obscured by woody or marsh vegetation was not included. The draft Environmental Impact Statement indicates that a number of backwater areas have been adversely affected by dredge spoil disposal; however, it is not indicated how much natural sedimentation has added to this problem. No quantification is provided on the amount of damage which was caused by the disposal of dredge spoil materials. The use of 1940 maps for the determination of dredge spoil sites disregards approximately 20 million cubic yards of material disposed of between the years of 1933 to 1940, as shown on Exhibit 76. Thus, dredge spoil sites as indicated on the 1940 maps would have been shown as existing sites and disregarded in the survey.

Response: In the referenced paragraph on page 306 of the draft Environmental Impact Statement the following statement is made, "... about 2,370 acres of spoil sites have been identified..." The word "about" should be noted as qualifying the statement . The last sentence in this same paragraph states that "... the full extent of areas affected is not indicated because some of the spoil is under water or is obscured by woody or marsh vegetation." We do not believe that acreage of spoil, which was obscured by woody or marsh vegetation and therefore excluded from the above estimate, was significant. This is because the characteristic fan-shaped nature of the spoil deposits usually shows up even when vegetated.

Comment (10,6): We seriously question the general classification of vegetation which eventually occupies open sand dredge spoil sites as "typical bottomland vegetation." Moisture factors and sterile environment of spoil sites make natural revegetation difficult and severely limit the establishment of "typical bottomland" species. This is borne out by the EIS itself on page 583.

We also believe that to say that "some 45 percent of the identified spoil deposits are presently vegetated to a significant degree with bottomland woods and brush" is questionable on the basis of the true vegetative types. Natural revegetation is principally limited to willow and cottonwood, with little ground cover and few typical bottomland species. Therefore, even where such vegetation has occurred, it does not represent a true recovery of the natural river environment.

Response: Comment noted. The sentences have been modified as follows: "The obvious short-term trend is for aquatic habitat to be converted to open sand and for the open sand to eventually become overgrown with vegetation." and "Based on the estimates given in Exhibit 186, same 45 percent of the identified spoil deposits are presently vegetated to varying degrees with trees and/or brush." on page 215 of the final EIS.

Comment (18): Page 307, First Paragraph - The statement that 45% of the spoil deposit sites are vegetated to a "significant degree" with bottom land woods and brush is meaningless. The quality of the dredge spoil sites for wildlife habitat cannot be ascertained by the use of such vague and general descriptions. Much of this cover can be attributed to the presence of existing trees which have been spoiled to their crowns and by the invasion of cottonwoods and willow. This does not give any information, however, on the occurrence of ground cover which is valuable for wildlife habitat and for erosion protection.

Response: Comment noted. The sentence has been modified. It was not the intention to imply that a qualitative analysis was attempted. However, it is expected that research studies currently under contract will include more detailed information.

Comment (18): Page 307, Second Paragraph, Second Sentence - It should be noted that the areas which are indirectly affected by spoil deposition can be rather extensive. A good example is the spoil deposits located at the mouth of Indian Slough at approximately River Mile 759. Examination of backwater areas in this region by comparing 1939 aerial photos to recent aerial photos shows an extreme change in habitat and sedimentation. While all of the sedimentation cannot be blamed on dredge spoil disposal, it appears that a good share of

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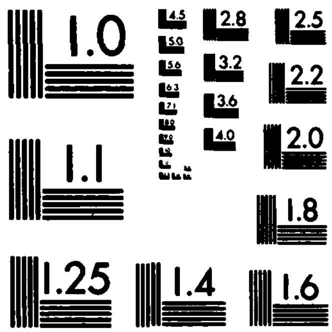

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the sedimentation is a direct result of it. The indirect results of loss of water circulation in backwater areas has not been adequately considered in this section.

Response: A discussion of possible indirect effects resulting from dredge spoil deposition has been included in the final EIS on page 215.

Comment (41): Page 308 - While recovery by sprouting and seed germination is possible in the open sites or in willow-cottonwood stands, it is difficult or impossible in the stands of mature elm, maple, and ash. The normal early colonizers of sand are shade intolerant and do poorly in the shade cast by the mature trees. The seedlings and saplings with normally low densities in these mature stands are most susceptible to damage from spoil deposition. Commonly the result of spoil deposition is the removal of the successional understory. Death by disease, such as Dutch Elm Disease, or normal senescence of the remaining overstory can result in the complete elimination of mature bottomland forests. Normal successional patterns are distorted, resulting in the development of new disclimax of questionable value.

Response: The entire paragraph is included on page 218 of the final EIS.

Comment (18): Page 309, First Sentence - It should be clarified which species of trees inhabiting the river bottoms are capable of forming adventitious roots. According to Curtis (1959), the leading dominants of the lowland forest are silver maple, American elm, green ash, black willow, cottonwood, river birch, and swamp white oak, all of which are wind pollinated and have seeds or fruits which are wind disseminated. All of these species produce stump sprouts; however, none have a well-developed ability to grow from root sprouts or to form dense vegetative clumps.

Response: It is believed that willows and cottonwoods effectively form adventitious roots. As to the remaining species capabilities, it is not presently known which other tree species are also capable of forming adventitious roots. In response to the subject comment, the acorns or fruits of swamp white oak (Quercus licolos) are not usually considered capable of being wind disseminated.

Comment (18): Page 310, First Paragraph, Fourth Sentence - It is important that dredge spoil sites be revegetated in order to prevent wind and water erosion.

Response: Comment noted.

Comment (18): Page 310, Second Paragraph, Third Sentence - We would like to know if revegetation studies are going to be undertaken on dredge spoil islands.

Response: Revegetation of dredged spoil material is currently under investigation by the University of Wisconsin - La Crosse and Winona State College. Studies are being conducted in pools 8 and 5, respectively.

Comment (18): Page 311, Sixth Sentence - We would like to know what types of wildlife habitat are created by ecological succession of vegetation on dredge spoil sites. Inspections of dredge spoil sites in the past five years, including some sites that were 2 to 4 years old, indicates only transient use by wildlife other than turtles and songbirds. Most spoil sites checked were virtually devoid of wildlife.

Response: Subject sentence has been modified as follows: "However, the ecological succession of vegetation on spoil sites is also creating habitat for other forms of wildlife such as songbirds and turtles." on page 218 of the final EIS.

Comment (18): Page 311, First Paragraph, Second Sentence - Dredge spoil sites are not important for the provision of grit to birds. Grit is available on any terrestrial site in the bottom lands including roadways, gravel pits, and natural shorelines.

Response: That particular portion of the indicated sentence has been deleted.

Comment (11): Page 311, Paragraph 1 - The last sentence implies that although there is a loss of habitat for some wildlife, the dredge spoil is creating compensation by producing habitat for other species. This sentence may be misleading. Each dredging site and spoiling site is an individual problem. Habitat for certain species is invaluable and cannot be compensated by producing habitat for other species.

Response: It was not intended that the reader be misled into believing that altered sites were effectively an equitable exchange of habitat types. The intention was to present the idea that habitat loss is partially mitigated by the gain of another type.

Comment (18): Page 312, Paragraph 1, Third Sentence - The extent of killing of floodplain trees and the length of time they remain as

possible nesting sites for herons and egrets should be examined and evaluated along with the assessment of any possible damage due to dredge spoil disposal to existing rookeries. The alteration of habitat almost always results in new habitat where something else will live. The question which must be raised, is the change desirable or necessary? As the heron rookery illustrates, the habitat created could be unnecessary for certain uses. More nesting would not necessarily mean more birds or turtles if other limiting factors were more influential. For example, eagles may already have a plentiful supply of available perches without the killing of more trees to increase the supply.

Response: The sentence in question has been corrected to apply only to black-crowned night herons, although the rookery is large by any standards. The sentence has also been placed in a paragraph of its own since the killing of trees by spoiling does not have a positive effect on herons, but rather would have a negative effect in the event that rookery sites is avoided when their presence is known.

While the comment recognizes the value of having some areas in an early stage of ecological succession, the question it raises is whether the amount of such habitat is optimal, less than optimal, or over-abundant. This has not been determined.

Comment (18): Page 312, Second Paragraph, Second Sentence - The aquatic habitat is not only restricted to the spoil site; however, this is the most obvious effect. Losses or changes in aquatic habitat of backwater areas are indirectly affected by spoil deposition which results in sedimentation and disruption of flows.

Response: The final EIS has been revised to include the above information on page 219.

Comment (18): Page 313, First Paragraph, Third Sentence - Many lesser appreciated forms of aquatic animal life are important to ecological relationships which are not yet fully understood.

Response: Comment noted.

Comment (18): Page 313, First Paragraph, Last Sentence - Protecting waterfowl brooding and nesting areas which are utilized for food and cover are important in this respect.

Response: Concur. Subject information has been included on page 220 of the final EIS.

Comment (18): Page 315, First Paragraph, Second Sentence - It is unusual that no discussion has been undertaken on the decrease of wild rice beds and American lotus beds both of which were extensive during the 1950's. Both of these species have apparently declined considerably in recent years.

Response: Comment noted.

Comment (6): This section, Channel Maintenence, should comment more fully on impacts rather than referring the reader to exhibits to analyze those impacts. The generalized descriptions of what happens to submerged plant and animal life should be better documented and impacts on land species should be included. Related impacts on human use should be included.

Response: The referenced section has been modified in the final EIS. We feel that the exhibits definitely aid in the overall understanding of the environmental impacts of operations and maintenance, therefore the referals to these exhibits have not been omitted in the final EIS.

Comments (4, 18): Page 316, Second Paragraph - This paragraph is not clear with respect to the source of turbidity which has had a significant effect on the absence of bottom organisms. If the turbidity at the cutterhead is not significant, the only other source of turbidity would come from the discharge pipe. Where excessive turbidity had an adverse effect on bottom organisms, the discharge would be considered to be a pollutant. Data on the actual amounts of cutterhead turbidity should be included to support the statement claiming such turbidity to be insignificant.

Response: The experimental design employed in this experiment did not test whether the cutterhead produced "significant" quantities of sediments downstream. Direct observations of water clarity indicated that actual cutterhead activity and the activity of the thrusting screws of the dredge and tender boats was not significantly noticable.

The loss of benthic organisms after dredging was due to the runoff material from the spoil site itself. The primary areas affected were those stations located immediately adjacent to the runoff site. The removal of benthic organisms was accomplished by simply overlaying the existing sediments with varied depths of spoil material. Data on cutterhead turbidity is not available.

Comment (18): Exhibit 187, Page 206 - We wonder how it is possible to arrive at the accuracy of the indicated water quality parameters to three significant figures.

Response: The accuracy of the data is limited to two significant figures. Appropriate revisions have been made in the final EIS.

Comments (6, 18): The opportunity to fish, hunt, and trap that has decreased as a result of habitat degradation is not fully evaluated. Blockage of travel routes utilized by fishermen, hunters, and trappers is discussed on page 318. The statement states that there is no major problem at Wyalusing Slough entrance or at the entrance to Harper's Ferry since the entire 1964 spoil deposit washed away. The statement should explain what happened to the spoil that washed away and why the Corps continued to spoil in the mouth of Wyalusing Slough after 1965 (i.e.,Wyalusing, 45,000 cubic yards in 1966; 97,000 cubic yards in 1968; and 81,000 cubic yards in 1969).

Response: The decrease in opportunity to fish, hunt, and trap as a result of habitat degradation due to operation and maintenance activities has been expanded in the final EIS.

Both the draft and final EIS indicate that there is definitely a major problem involving access to Wyalusing Slough on the Iowa side of the river. The degree to which dredge spoil is involved in this reduced closure is not clear, however, much of the access problem appears to be due to the location of a closing dam at the upstream end of the entrance to Wyalusing Slough. The dredge spoil disposal placed at Wyalusing Slough was coordinated with the State of Iowa in 1969.

Our records show no indication of placement of dredge spoil in the entrance to the backwaters at Harper's Ferry. Due to the lack of documented evidence that such a disposal was made, the referenced statement has been removed from the EIS. If such a disposal did occur, however, the spoil was apparently washed out of the slough by subsequent floods and does not appear to cause a problem at the entrance to this slough.

Comment (11): Page 319, Second paragraph - The Weaver Marsh has been adversely affected by dredge spoil operations, natural sedimentation, and poor land use planning and development. The reopening of channels into the marsh area and changes in dredge spoil operations should be investigated to correct this problem.

Response: Comment noted.

Comment (4): Page 321 - The statement in the last paragraph on this page indicating that Gibbs Slough filled with sand, even though it had never been used as a disposal site, tends to create an

erroneous impression. The slough, in fact, could well have been significantly affected by the project in any or all of the following ways: (1) the pool created by the lock and dam could have changed the sedimentation pattern and carrying capacity of the river; (2) spoil deposited in other areas could have been redistributed to Gibbs Slough; and (3) dredging of the navigation channel could have had an effect on current pattern and siltation, along with the pool creation mentioned above.

Response: Available dredging data shows no record of spoil deposition within Gibbs Slough. Identifiable spoil sites upstream of Gibbs Slough (see Exhibit 38) are located so as to make it doubtful that the filling of Gibbs Slough could be attributed to direct movement of spoil from existing disposal sites. In other words, the responsibility for the filling of Gibbs Slough does not appear to be related to O&M activities. However, the presence of the 9-foot project may have changed natural sedimentation patterns and contributed to the filling of the slough. The text of the EIS has been modified to reflect this possibility.

Comments (10, 18): Page 321, Second Paragraph - This is a comparison of two entirely different ecological condition; a) a slough in a natural river condition which had been affected by the 4 1/2-and 6-foot navigation structures resulting in the deposition of sediments before the installation of L&D 6.

When the water in the pool raised, the slough became a settling basin for sand from the upstream, part of which likely came from the numerous dredge spoil sites below Winona and Homer, Minnesota. Although the filling of Gibbs Slough may not be completely due to dredge sand, it is certainly the result of the construction of L&D 6 inundating the area. b) the same slough after it had been ecologically altered by impoundment and subsequent sedimentation. The implication that Gibbs Slough would have filled in even though left in a natural condition does not necessarily follow since it was changed from a running slough to a backwater lake. In any event, whatever happened to Gibbs Slough does not change the fact that dredge spoil is environmentally damaging where it occurs.

Although some sedimentation of Gibbs Slough may have occurred normally under unimpounded conditions during flood stages, it should be recognized that certainly any decreases in sedimentation would be another side benefit of stopping erosion before it occurs in such areas as the Chippewa River.

Response: See response to the previous comment.

Comment (11): Page 321 - The obvious conclusion from Surber's study is that conditions of sedimentation have drastically changed since 1928. Also, these changes would appear to be in the proper chronology to coincide with the construction of the 9-foot channel and the associated operation and maintenance activities. So this would appear to be documentation of the fact that the dredging operation has caused the filling of a ski-water area.

Response: See previous Comment/Response.

Comment (6): Recreation needs should be closely correlated with the following section on Public Health and Safety to interrelate the expected rise in use of the river to an increasing chance of serious accidents on or near spoil islands. The Recreation section should address the heavy use of particular areas. Spoil islands dedicated to recreational use would then have more relevancy to the impact statement, particularly as alternatives are considered.

Response: Due to the general lack of suitable areas for camping and day use, dredge spoil areas are becoming more desirable locations for these activities. Since the river rise is gradual, no safety hazards are anticipated. The boat traffic among the spoil islands is not expected to be any greater than elsewhere. Caution is a major factor to be considered with boating at all times. One of the greater problems with use of the spoil areas is housekeeping. No consideration has been given to providing sanitary facilities. Arrangements have been made by the BSFW to collect the garbage. However, recently the BSFW has begun a campaign of educating the boater to take his garbage with him. Plans are under consideration to provide mobile toilets that can be moved off the spoil areas during periods of high water.

Comment (12): The draft EIS repeatedly refers to the sand beaches of the spoil piles as providing valuable nesting areas for turtles, however, no shortage of turtle nesting sites is documented. Also, the spoil pile beaches are cited as valuable and attractive recreational areas, however, it fails to express the magnitude and scope of the litter, garbage, sanitary and other adverse environmental problems associated with such recreational uses. These ideas should be developed with information available through the Upper Mississippi Wildlife and Fish Refuge personnel.

Response: We agree that there is presently not a shortage of turtle nesting habitat. However, we disagree with your statement that the draft EIS "fails to express the magnitude and scope of the litter, garbage, sanitary and other adverse environmental problems" associated with recreational use of dredge spoil areas. We feel that this subject is adequately discussed on page 323 of the

draft EIS. It is also stated on this page that the present situation warrants a study to determine the level of facility development which would be required to adequately provide for present use and also to estimate future use.

Comment (18): Page 324, First Paragraph - As discussed previously, most of this natural sedimentation is due to the presence of the locks and dams which resulted in an increased water depth and decreased water velocities causing a net deposition of sediments in areas where the depth was previously maintained by scouring.

Response: Although the locks and dams have contributed to backwater sedimentation, we lack sufficient supporting data to suggest that "most" of the natural sedimentation is due to the locks and dams.

The text in question discusses the effects of dredge spoil rather than effects related to the presence of the locks and dams because the primary focus of this EIS is on environmental impacts related to O&M activities, not the locks and dams themselves.

Comment (18): Page 324, First Paragraph, First Sentence - It should be mentioned that this area is one of the most extreme examples of river channelization due to dredge spoil disposal in the whole St. Paul District.

Response: Comment noted.

Comment (6): It is mentioned on page 323 that the present situation warrants a study to determine the need for facility development. The Master Recreation Plan mentioned on page 268 may alleviate the need for the study in question.

Response: The study referred to concerns updating of the Master Plans for Resource Management which should be accomplished to reflect current conditions.

Comment (18): Page 324, Paragraph Three, Second Sentence - We would like to know if these studies will be initiated?

Response: As of 10 June 1974, the St. Paul District received

authority from the Chief of Engineers to conduct studies of backwater chute shoaling in coordination with the Bureau of Sport Fisheries and Wildlife. If these studies can establish that the material is definitely caused by secondary movement of dredge spoil, dredging of the chute can be considered. Sand Run would appear to have a relativily high priority for additional review.

Comment (6): The impacts of pollution from recreation boaters also should be discussed in the Public Health and Safety subsection (page 324).

Response: Until all States impose the requirements for a holding tank or the provision of adequate toilet facilities aboard boats, there are no assurances that some boaters will not pollute. The requirement for holding tanks makes pumped dump stations a necessity and no agency, State or Federal, has agreed to provide such facilities.

Comment (6): We suggest the subsection entitled Public Health and Safety under Environmental Impact of Operation and Maintenance be rewritten to identify the direct safety hazard to people utilizing the beaches next to deep, fast water. Unstable and unpredictable bottom conditions exist at the edges of new spoil deposits and also in the shoaling areas downstream. Drownings have occurred in such areas in other districts. Additional danger exists where spoiling is done in these areas which would be hazardous even to good swimmers. The situation at lock and dam No. 7 is a good example of this danger. At the head of Lake Pepin, a swimmer or wader along a spoil beach might suddenly find himself a mile or more from shore. Dangers to swimmers and recreational boaters at new and naturally eroded spoil sites should be incorporated into the final statement.

Response: It is impossible to identify all areas that boaters or recreationists could encounter under all conditions. Further, without an annual survey of each spoil area there are no assurances that the previous years indication is still valid. Such surveys could be misleading. Whether a boater or recreationist is a mile or more from shore does not make an unsafe situation any less safe. It is assumed that the boater is aware of the inherent dangers associated with the water.

Comment (18): Page 325, Second Paragraph, First Sentence - These beaches, particularly when located near too swift currents on the channel side, may present hazards to swimmers and water skiers. At these locations, the bottom may drop off rather rapidly and swimmers may be caught in swift currents. Another safety hazard which should be considered is that the edges of freshly deposited spoil

sites are very soft. People stepping on these new spoil sites have been known to sink several feet into the dredge material.

Response: Refer to previous Comment/Response.

Comment (18): Page 325, Paragraph Two - Safety hazards from commercial tows are not restricted to only the vicinity of the locks. Lighting of barges at night is frequently inadequate for safe visibility.

Response: Comment noted.

Comment (8): The contention is raised that the dredging and the placement of spoils has the potential to adversely affect the quality of the aquatic environment, and therefore the human environment as well. More definite, we feel, is that navigation and anchorage on the Upper Mississippi River will be adversely affected if dredging is not maintained. We also feel that this would lead to a more definite impact to the way of life of people who derive their livelihood from the river or depend on it for products and services. If the river transport of commodities stops, those living in the area would be affected by increased prices for products and services, or their disappearance altogether. To us it appears that the slowing or stoppage of navigation on the Upper Mississippi River is the more serious impact. The importance of river navigation in the region's transportation planning should be stressed.

Response: Comment noted.

Comment (6): The Economic section (page 325) discusses only those economic benefits to recreation, but it is difficult to define those benefits that are deemed solely O&M. It would be proper to separate all benefits as to the project itself, O&M, and what would occur without the project and operation and maintenance.

Response: The referenced section of the draft EIS also discusses the topic of commercial shipment of commodities as referenced to a benefit of the project, and operation and maintenance of the project. Separation and identification of the benefits that accrue to the project and to the operation and maintenance of the project would be extremely difficult, as any benefits that accrue to the project are usually also dependent upon the subsequent operation and maintenance of the project. The identification and quantification of benefits would be a proper subject for justification of a project and an EIS prepared

for the project, however this EIS is prepared on the operation and maintenance of the project and a detailed analysis of pre- and post-project benefits was not undertaken. This section has been revised in the final EIS.

Comment (40): Extensive navigation improvements would have a serious adverse effect on the railroad industry and would not represent efficient use and conservation of our nation's resources. The extensive commercial navigation improvements being proposed in the Upper Mississippi River basin would result in a serious diversion of traffic and much needed income from the railroad industry. As an example, the proposal to replace or duplicate the locks at 18 to 32 existing lock locations on the Upper Mississippi River and Illinois Waterway at a current estimated cost of 1.7 to 2.2 billion dollars would, according to the Corps, increase the annual waterway traffic tonnage in the Upper Mississippi River Basin from the current level of about 65 million tons to an estimated level of about 220 million tons during the next 50 years. Most of this traffic in the absense of the lock replacement or duplication improvements would move by rail. Also, the estimated rate savings to the potential waterway shippers would represent little more than a diversion of potential net income from the railroads.

Response: Proposed improvements to the system, while noteworthy in the EIS, are not critical to the report purpose. Commercial navigation improvements are not currently proposed for the Mississippi River within the St. Paul District. Any proposed improvements would have to be evaluated on their own merits.

Comment (7): A secondary impact resulting from the proposed action will be the need to continue the operation and maintenance of highways and railroads as distribution systems to and from the terminal facilities adjacent to the Navigation Channel. To better measure these secondary impacts, an estimate of the tonnage now handled and anticipated to be handled by railroads and truck transport from the terminal facilities would be beneficial. In this Region we are primarily concerned with facilities adjacent to Pool Ten.

Response: We agree that such secondary impacts would occur and be related to the continued operation and maintenance of the 9-foot channel. Measurement of these secondary impacts is not readily obtainable. However, we do not feel that these impacts are of major significance to the determination of the impacts and effects of the operation and maintenance of the 9-foot channel system. Should such information be available if the EIS is revised or updated, it could be included if it is determined to be meaningful and/or significant.

Comment (7): Another indirect impact will be associated with the potential for increased economic, commercial, industrial, and residential growth adjacent to the channel. Dependent upon the existing physical alignments and usage of highways, such potential or encouraged growth could require the reconstruction or betterment of many highways.

Response: Comment noted.

Comments (10, 18, 40): Pages 325 - 327 - The subsection on Economic Impact of O&M suffers from the same deficiencies as the section on page 271. These deficiencies should be rectified in the final EIS. Economic benefits listed are not quantified. Economic costs in terms of first costs of building the 9-foot channel system and continuing costs for O&M are not given. Although tonnage figures for 1971 cargo movements (why not 1972 as on page 176 and 277?) are given, no estimate is made of the value of cargo shipped on the waterway. Also, no reference is made to the obvious economic impacts of the project, both positive and negative, on other competing modes of transportation. Economic costs and benefits related to impacts of the project on fish, wildlife and recreational uses are not mentioned. These deficiencies should be corrected in the final EIS.

Response: Although the referenced sections contain a rather limited summary of the economic impacts of the project, a more detailed breakdown and quantification of benefits and first costs related to the project is not believed to be necessary. Annual costs for operation and maintenance activities are presented in Section 1, Description of Major Federal Action, in the final EIS. The information presented regarding the economic impacts of the project is believed to be sufficient to present an adequate picture of effects and impacts of operation and maintenance of the 9-foot channel project. Although additional information regarding the effects and impacts of the 9-foot channel project on competing modes of transportation, and on the economic costs and benefits related to fish, wildlife, and recreational uses would be desireable, this information is either non-existent or difficult to evaluate and is not believed to be essential subject matter for the EIS.

Comment (39): On page 326 it is indicated that based on present waterborne commerce growth rates traffic in the St. Paul District will double by about 1976 or 1977 and will triple well in advance of the year 2000.

Response: In general, traffic levels for all locks in the St. Paul District are projected to increase about 60 percent between 1970 and 1980. Only at lock 2 are tonnages projected to triple by 2030. Tonnages at the other locks in the district are projected to more than double between 1970 and 2030 (see Exhibit 106 in the final EIS).

Comment (10): Page 326 - By using waterway traffic projections derived in 1964, the suggestions that barge tonnage is expected to double from 1964 to 1980 and triple from 1964 to 2000 appear to be overstatements. Later data, in table 1 on page 11 of the Corps' Phase I Report on the Mississippi River-Illinois Waterway 12-foot Channel Study (September 1972), indicate that tonnage may double by 1980 for locks 5 through 10 (but not for locks 1 through 4); however, tonnage would not be triple the 1964 level until 2020, and then only for locks 8 through 10. We recommend modification of the EIS on this point, both in the text and in Exhibit 106.

Response: The latest waterway traffic projections on the Upper Mississippi River are shown in table 4, Phase I Report Mississippi River Year - Round Navigation, prepared by United States Army Engineer Division, North Central, Corps of Engineers, Chicago, Illinois in September 1973. Traffic levels by locks 1 - 10 are shown in Exhibit 106 of the final EIS.

Comment (13): It is the request of the Minnesota Historical Society that the Society and the State Archaeologist be informed as to the proposed locations for deposit of dredge spoil and construction. These locations known, it will then be possible to assess the resulting effect with reasonable accuracy. Proposed spoil and construction sites should list alternative locations which would take into consideration avoidance areas exhibiting high archaeological or historic potential.

Response: Dredging and deposition since the development of the 9-foot channel has had little known impact on the historical and archeological resources. Most of the adverse impacts occurred when the impoundments were first formed. Upon finalization of plans for off-channel spoil deposition, it is planned that each state historical coordinator be contacted and informed of the location of proposed disposal sites. Arrangements will then be made with the respective State historical society to investigate the proposed spoil disposal area to determine the impact and, if necessary, recommend another site.

Comment (6): It would be proper for the statement to consider correcting damages from O&M such as revegetating spoil sites and reopening side channels closed by dredge spoil. No mention is made in this section of compensating for environmental losses caused by destructive spoiling operation or any concrete plans for disposal area selection to minimize harm.

Response: Revegetation (page 359 DEIS) of dredged materials and backwater channel openings (page 401 DEIS) are adequately discussed

in the Alternatives section of the draft EIS and final EIS.

The Statement of Findings, which accompanies this EIS, discusses the recommendations regarding the findings of this EIS, and as appropriate, discusses the need for implementation of measures to correct or minimize adverse effects on the environment caused by operation and maintenance of the project.

Comment (6): This section, Remedial, Mitigative, and Protective Measures, discusses only limited protective measures that have been initiated recently through cooperative efforts of environmental interests and the Corps of Engineers. The placement of spoil was not accomplished according to the desires of the Bureau of Sport Fisheries and Wildlife. Extreme limitations of the Corps of Engineers equipment largely governed spoil placement. The alleged expenditure of $100,000, apparently to break pipe for passing tows and to reduce environmental damage, is a small sum when compared to the millions that are spent annually on maintaining the channel.

Response: Refer to the following Comment/Response.

Comment (18): Page 328, Remedial, Mitigative, and Protective Measures - On page 329, it has been pointed out that resource agencies have been contacted regarding the location of dredge spoil sites, and that the placement of spoil in preferred areas costs about $100,000 annually. There is some question regarding the validity of this statement since dredge spoil material has continually been deposited in "sensitive" areas. The Wisconsin Department of Natural Resources and the UMRCC have had the choice of few alternatives for dredge spoil disposal, all of which were not acceptable from a resource protection standpoint. In part the decision to rescind the 1969 dredge spoil survey was based on its misuse. The limits of available dredging equipment and the present mode of operation constitute the majority of the problem.

Response: The referenced statement has been modified in the final EIS on page 229 to clarify the current dredge spoil disposal practice.

Comment (11): Page 329, Second paragraph - Updating of UMRCC designated spoil area study and damages from spoiling is recommended.

Response: Comment noted.

UNAVOIDABLE ADVERSE IMPACTS OF OPERATION AND MAINTENANCE

Comment (20): The discussion of unavoidable impacts in both the summary report and the pool reports seems very brief and general. There is no indication of the significance of these unavoidable impacts.

In both discussions of the impacts of the project, a clear listing of the objectives of the project would be very useful in assessing the impacts. The question which is unanswerable is, "Does the need for the project override the detrimental effects of the project?" This section does not discuss "remedial, protective and mitigation measures which would be taken as part of the proposed action by the Corps or others to eliminate or compensate for any adverse aspects of the proposed action." (Corps EIS guidelines)

Response: The general significance of the unavoidable adverse impacts is represented in the draft Environmental Impact Statement by the statement that the most significant direct adverse impact is the conversion of aquatic habitats to sandy shoals or islands as a result of the placement of dredge spoil. This results in areas of lesser fish and wildlife value.

The "need" for the project is not a subject of the EIS, rather the project related impacts are described in the Environmental Setting section of the EIS. The "need" for the project, and subsequent operation and maintenance activities and associated benefits and detrimental effects, have not been balanced in the EIS. This balancing action must be made by the reader. An objective statement of facts is presented in the EIS. The Statement of Findings which is attached to the final EIS discusses the results of the study and recommended actions to reduce or alleviate the adverse impacts of the operation and maintenance activities.

Comment (18): Page 331, First Paragraph - This statement in effect states that the Corps cannot stop maintaining a 9-foot channel that has been authorized by Congress. Many of the adverse impacts, such as the change of aquatic habitat to sandy shoals, which are claimed to be unavoidable adverse impacts are not necessarily so. Under the present method of dredge spoil disposal, this would be true. With proper modifications, however, these adverse environmental impacts could be mitigated or avoided. This could be done without sacrificing the authorized purpose of the project. Thus, maintenance of the 9-foot channel could continue without the present destructive methods used in the disposal of dredge spoil materials.

Response: The referenced paragraphs have been revised in the final EIS on page 231. Many adverse environmental impacts of the present operation and maintenance activities could be reduced or avoided if certain alternative measures were taken, however, the conversion of habitat from one type to another is generally regarded as unavoidable, only the type and magnitude of the conversion would be in question.

Comment (10): References to unfamiliar term "channel border" have been made without definition. (It was ultimately discovered by accident that this and other terms used throughout the statement are described in Exhibit 194 under the obscure title"Explanation of Impact and Effect Parameters Used on the Alternative Plans Comparison Exhibits.") Recommend that this list be put in the final EIS as a "Glossary."

Response: We have assumed that terms such as "channel border" would be self-explanatory to the average reader. Whenever technical terms were used in the draft EIS an attempt was made to describe the term in a parenthetic phrase. As an example,in the first paragraph on page 137 of the draft EIS this method is used to describe the terms "benthos" and "aufwuchs". If the reader desires additional information, he can refer to Exhibit 194 and/or the Environmental Assessment Reports prepared by North Star Research Institute.

Comment (18): Page 331, Second Paragraph, Last Sentence - Assuming that the dredge spoil sites receive considerable public recreational use, it could not be considered as an unavoidable adverse impact of the operation and maintenance of the 9-foot channel. Therefore, this sentence should be changed or deleted from this section.

Response: Concur. The recreation values of dredge spoil beaches are adequately discussed in the draft EIS. The above referenced paragraph has been revised in the final EIS on page 231.

Comment (6, 10): The statement that "maintenance of a navigation channel requires dredging and the disposal of spoil" implies that there are no alternatives available. This ignores the possibility of retention of sediment within the tributary watersheds and, at least, should be qualified to reflect the variations in the amount of dredging which might be necessary under various conditions. We cannot accept the assumption as presented since it infers that it is "unavoidable."

Response: The maintenance of the 9-foot navigation channel would require some degree of dredging and subsequent spoil disposal. The amount and type of material to be dredged could vary depending upon whether any of the various alternatives to present operations and maintenance activities were used. We believe, however, that it is reasonable to assume that some dredging and spoil disposal will be required to maintain a 9-foot channel, regardless of whether or not any of the alternatives are implemented.

Comment (28): Page 331, Paragraph 3 - "Since the maintenance of a navigation channel requires dredging and the disposal of spoil, it is impossible to avoid some form of habitat conversion without sacrificing the authorized purpose of the project."

A delineation should be made between the act of channel dreding and subsequently the act of spoil disposal. There appears to be little doubt

that continued maintenance requires channel dredging; and such dredging will obviously affect the site of the dredge cut. The act of dredging will affect downstream turbidity etc. as outlined in the statement. However habitat conversion due to spoil disposal is not necessarily impossible to avoid. Relocation of spoil from the floodplain may have no adverse effect on aquatic habitat. This factor should be more clearly explained in the final Environmental Impact Statement and the above-quoted statement revised.

Response: The referenced statement has been revised to indicate more specifically the maintenance of the 9-foot navigation channel. However, the disposal of spoil will result in some form of habitat conversion wherever the spoil is placed. The conversion could include terrestrial habitat of one value to terrestrial habitat of another value. Also refer to previous Comment/Response.

Comment (18): Page 322, Second Sentence - The issue here is not floodplain construction or the natural movement of sedimentation, but the depositing of dredge spoil material and its secondary movements. As a result, the real questions remain unanswered. The purpose of this Environmental Impact Statement should have been to evaluate the environmental impacts of the present mode of operation and the various alternatives. Its purpose should not have been to report that nobody knows what is happening. The logic behind many of these vague statements seems to be that because there is some habitat loss which would occur without dredge spoil disposal, there is no need to prevent habitat loss which is directly caused by the present method of dredged spoil disposal.

Response: The evaluation of environmental impacts of the operation and maintenance of the 9-foot channel project conducted in the preparation of this EIS did not provide conclusive evidence as to the role of maintenance dredge spoil with regard to isolation of backwater areas and subsequent adverse environmental impacts in these backwater areas. Additional study is required to define this relationship more fully. Since the full extent of this relationship is unknown at the present time, additional information should be gathered before embarking on a full-scale program to treat a problem to which the cause is unknown. Smaller scale studies are being conducted, are being planned, and/or are being recommended to clarify some of these issues. Changes to the present method of dredge spoil disposal could be considered where it is definitely causing adverse environmental impacts which are intolerable and as such, alleviation of the impact would justify the required changes.

Comment: Page 332, Second Paragraph - A statement is made that improperly designed confined spoil areas would take up large areas of valuable biological bottomland habitat. Certainly, confined spoil areas would take up no more than what is presently taken by unconfined disposal, and if properly done, would in fact include less destruction of valuable habitat. These confined spoil sites could still retain aesthetic appeal.

Response: Confined disposal areas, even with proper engineering design, would take large areas of valuable wildlife habitat, and, depending on the specifics of the situation, could take up larger areas than by utilizing unconfined disposal methods. The relative aesthetic values of confined disposal areas would depend on the type of confinement method used and on individual values. Refer to the discussion on the confined disposal alternative in Section 6 of the final EIS for more detailed information on this subject.

Comment (10): Turbidity created in spoil placement is avoidable by using confined disposal. The final EIS should not draw the conclusion that this disposal technique is too expensive, or biologically and aesthetically unacceptable. This judgment hinders independent judgment and, furthermore, such a practice would not result in "sacrificing the authorized function of the project."

Response: As was mentioned on page 332 of the draft EIS, turbidity "is essentially unavoidable" without the construction of confinement facilities. Refer to the previous Comment/Response.

Comment (10): Page 332 - Secondary movement of dredged spoil is cited as an unavoidable adverse impact. This could be avoided by using confined disposal areas, riprap, or disposal out of the floodplain in the future.

Response: Secondary movement of spoil would be essentially unavoidable without the construction of confinement facilities, riprap or removal from the floodplain. Refer to Section 6 for detailed discussions of the various alternative measures referenced above.

Comment (18): Page 332, First Paragraph, Second Sentence - It should not be implied that there would be no sand beaches or sand bars without the present method of dredge spoil disposal.

Response: Concur. We do not believe that such an implication was made in the above referenced paragraph.

Comment (6): We agree that the barge transportation industry is one of the primary beneficiaries of O&M. Yet, the section on Unavoidable Adverse Impacts of Operation and Maintenance (page 333) notes only one of the many unavoidable impacts; and in this instance, the reference to the increased possibility of spills actually is not considered as an impact of O&M. Barge accidents, spills, interruption of recreational traffic, increased turbidity, increased air pollution, and increased water pollution are serious primary and secondary adverse impacts caused by the presence of deep draft traffic that cannot be dismissed and should be thoroughly discussed.

Response: We believe that the above mentioned impacts are secondary effects of the 9-foot channel project and as such are discussed in the Environmental Setting under the subsection "Summary of Major Beneficial and Adverse Impacts of the 9-Foot Channel Project". This response also applies to the following four Comment/Responses.

Comment (18): Page 333, Third Paragraph, Second Sentence - Oil spills and spills of other hazardous materials are a related factor to the operation of maintenance of the 9-foot channel project. The more trips that barges make up and down the river and the larger the capacity of the barges, the greater the potential environmental damage. It is also known that barge movement creates a considerable plume of turbidity. Barge traffic and heavy recreational use contribute to other unavoidable environmental impacts such as erosion of banks, increased congestion on the Mississippi River, and a higher potential for accidental collisions.

Response: We do not agree that the above mentioned impacts are attributable to operation and maintenance. We believe that these are secondary impacts which are attributable to the 9-foot channel project. Refer to previous Comment/Response.

Comment (34): Page 333 - "The increasing probability of spills from barge transportation is recognized from some viewpoints as an unavoidable consequence of the operation of the project." We are concerned that while the involved report supposedly constitutes an environmental impact statement, very little consideration was given to recoverable and non-recoverable spills of hazardous polluting substances in the waterway. Reference is made to transportation economics in the absence of the 9-foot project. However, no effort apparently was made to quantify the adverse effects of pollution as the result of hazardous materials spills in the waterway, with and without the 9-foot project.

Response: Comment noted. Refer to previous Comment/Response.

Comment (39): Page 333 takes notes of the increasing probability of spills from barge transportation. Curiously, no facts or supporting evidence are offered to support this claim. Nor do statistics available from the U.S. Coast Guard support such a conclusion. Quite the contrary, the advent of double skin barges and improved methods and operating procedures have reduced barge spill accidents to insignificant levels.

Response: Comment noted. Refer to previous Comment/Response.

Comment (6): Since barge transportation is integrally related to project operations and maintenance and has been used previously to determine benefits, unavoidable adverse impacts resulting from deep water traffic should be addressed in this section. Such impacts include continual pollution resulting from normal river traffic and potential pollution associated with the shipping of toxic or hazardous products on the Mississippi River.

Response: Comment noted. Refer to previous Comment/Response.

ALTERNATIVES

Comment (10): In general, the draft EIS indicates that the St. Paul District of the Corps assumes the inevitable necessity of continuing to operate and maintain the 9-foot channel system essentially as it is now doing. This assumption severely limits the evaluation of all reasonable alternatives by decision-makers, particularly the Congress. The mere fact that the 9-foot channel project was authorized 44 years ago and has been operated and maintained for about 35 years is not sufficient reason to neglect the full range of alternatives. The presentation of the action to continue O & M of this project as though such a decision has already been made is contrary to the basic purpose of NEPA. It should be presented as a proposed action. Sec. 1500.7(a) of CEQ Guidelines specifies that "agencies should keep in mind that such statements are to serve as the means of assessing the environmental impact of proposed agency actions, rather than as a justification for decisions already made." Since the Congress is the public body responsible for the original authorization and annual funding of the project, it should be granted the opportunity to judge the propriety of the action independent of agency presumptions and in light of all the evidence presented in an EIS. CEQ Guidelines, Sec 1500.13 further states, "It is also important in further action (on existing projects) that account be taken of environmental consequences not fully evaluated at the outset of the project or program."

The final EIS should clearly state the environmental, social and economic impacts of the alternative,"Cease Operation and Maintenance of Navigation Channel," in realistic terms. NEPA requires a thorough discussion of this so-called "no action" alternative; this was not done in the draft EIS. The effects of this alternative should be quantified. Examples of the types of information lacking in the draft which need to be included in the final EIS to balance such a discussion are:

a. acknowledgement and description of existing alternative transportation modes, such as the railroads and highways which parallel the 9-foot channel in the river corridor and the major transcontinental pipelines serving the same markets as the waterway, together with analyses of their capabilities to handle the commodities shipped by waterway and the environmental impacts of their operation, maintenance and use as compared with the waterway;

b. a comparison of the true cost, including original capital investment and the nearly $7 million current annual public expenditure for 9-foot channel O&M in the St. Paul District, of moving goods and commodities by barge on the segment of the river covered by this EIS, with the true cost of moving them via other modes serving the same area; (this is essential to the realistic evaluation of the total economic impact of the project since the commercial waterway users, for whose traffic the project was built and is maintained, now pay no fees to cover the costs of providing the transportation artery they use);

c. An analysis of the actual energy requirements for shipments by waterway, rail, pipeline, trucks and air within the area directly served by the St. Paul District portion of the 9-foot channel project, rather than by citation of data based upon national averages or questionable studies, as was done in the draft EIS. (Our analysis shows, for example, that when movements by unit train on railroads with little or no grade, such as those along the river, are compared with like movements by barge requiring maneuvers, stops and starts for lockages, the unit train demonstrated a fuel consumption rate per net ton mile that was about one-half the rate of barge tows on a locking river, rather than 50 percent more than barge tows, as was claimed in the draft EIS. (Source: Federal Railroad Administration Report OE-73-4, November 1973 and Illinois Central Gulf Railroad.)

Response: The EIS does not indicate that the Corps "assumes" the inevitable necessity of continuing to operate and maintain the 9-foot channel system essentially as it is now doing. The entire purpose of the Alternatives section of the EIS is to identify and evaluate "reasonable" alternatives to the present method of operation and maintenance of the 9-foot channel project. The alternatives evaluated are believed to be presented in an objective manner, giving their relative merits.

The "Cease All Operation and Maintenance Activities" alternative discussion has been revised in the final EIS. However, a full analysis and comparison of the capabilities of all alternative modes of transportation is not believed necessary to adequately evaluate the merits of the alternative. The data necessary to establish these capabilities, as well as the true costs of movement of commodities via the various modes of transportation, is not currently available and would take a major multi-agency, as well as multi-industry effort to establish accurate and objective data. Further discussion on the energy intensiveness issue is set forth in the final EIS in Section 2, "Environmental Setting."

Comment (11): In Section 5, "Alternatives", we also have several specific comments later in this letter. We feel that this section should have contained more than 3 alternatives and we also feel that your first two alternatives should have been more thoroughly investigated. Alternative 1, "Cease All Operation and Maintenance Activities" and Alternative 2, "Operate and Maintain Other than a 9-foot Navigation Channel", were only explored in a few brief paragraphs. However, Alternative 3, "Modification to Existing Operation and Maintenance" was explored in over 200 pages. The final statement in the draft EIS for Alternatives 1 and 2 simply states "Any alternative to the modification and maintenance of the 9-foot channel would not be reasonable because of the controversy concerning the potential impacts that could be involved." We feel that the above statement is inadequate, especially when viewed with the limited investigation of Alternative 1 and 2.

We also believe that certain other approaches could be explored as alternatives. For example, we feel that the "do nothing" alternative, or Alternative 1, could be investigated with continual operation of the dams, however, with no dredging. Another possibility is investigation of a maximum 9-foot channel, instead of the minimum 9-foot channel. Included in such an alternative could be comparisons as to amount of dredge spoil between dredging only 9 feet, instead of the present 13 feet. Another alternative could include extensive land treatment measures to reduce the need for channelization. Finally, when all the alternatives have been investigated, comparisons between alternatives could be made as to costs, environmental damage, and other such criteria, in perhaps a matrix format.

Response: The discussion of the "Cease All Operation and Maintenance Activities" and "Operate and Maintain Other Than a 9-Foot Navigation Channel" alternatives has been revised and expanded in Section 6 of the final EIS.

The evaluation of the additional alternatives which are mentioned were essentially contained in the alternative measures write-up of the draft EIS and remain in the final EIS. The alternative measures investigated resulted in the further evaluation of alternative plans on a pool-by-pool basis including a "matrix" type presentation which is contained in the Exhibits section and is discussed and referenced in the text.

Comment (17): Educated and enlightened with the aforementioned "facts" and clearly defined and documented "adverse and beneficial impacts", the reader is given a choice of 241 pages of alternatives. With this kind of information in hand, it is needless to say that the average reader would be persuaded by a range of alternative costs varying from $740,000 per year ($.50 per cubic yard) for the status quo to $8,950,000 per year ($5.95 per cubic yard) for central disposal. However, the reader is not informed that these figures only represent production costs and do not reflect environmental costs. To further complicate the issue, the draft Environmental Impact Statement states on page 573 that, "Further consideration should be given to any alternative measure before it is recommended for implementation. In some cases, the actual feasibility and/or the specific impacts and effects of an alternative measure would have to be determined by a detailed study." With this presentation of information, one can only conclude that the existing Environmental Impact Statement is intended to justify the status quo alternative rather than to seek out alternatives which would minimize or reduce environmental degradation since no such detailed feasibility studies were done to determine the impacts and effects of present dredging operation. A further qualification is made on page 576 that "The status quo plan currently has Congressional authority, is within agency policy, and is being funded."

It is not mentioned, however, that this authority is over 40 years old and that Section 103 of NEPA requires that "All agencies of the Federal Government shall review their present statutory authority, administrative regulations, and current policies and procedures for the purpose of determining whether there are any deficiencies or inconsistencies therein which prohibit full compliance with the purposes and provisions of this Act and shall propose to the President not later than July 1, 1971, such measures as may be necessary to bring their authority and policies into conformity with the intent, purposes, and procedures set forth in this Act." Section 2 of NEPA states "The purpose of this Act are: To declare a national policy which will encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man... ."

Response: To judge what the reader's feeling toward the various alternatives would be after reading the EIS would be somewhat presumptious, although he would reasonably be expected to be cognizant of the economic costs of dredging as well as the social and environmental parameters which are also presented, discussed, and evaluated. The economic costs presented represent the cost involved to implement the respective plan and would in essence also indirectly represent environmental costs. The environmental parameters are discussed principally in a more general nature, relating to habitat type and quality.

The purpose of the EIS is to objectively discuss and describe the impacts and effects of operation and maintenance of the 9-foot channel and the relative merits of reasonable alternatives to the present methods of operation and maintenance. The alternatives were evaluated on a preliminary feasibility level and information relative to many of the alternatives is not considered of sufficient scope to implement them at this time, but rather to provide a means by which the most promising alternatives can be selected for more detailed analysis.

The Corps of Engineers is conducting studies on a national and local level regarding dredging problems encountered in the maintenance of navigation channels. Implementation of other alternatives which involve greater costs or that are outside of existing authorities and/or policies must depend primarily on the justification for implementation of such alternatives. It is anticipated that through the additional studies being conducted, sufficient justification will be obtained to implement at least some of those alternatives which would significantly reduce or alleviate the adverse impacts of the present activities, or, possibly enhance the environmental aspects of the areas affected by project activities.

Comment (6): The statement contains considerable amount of detail, identifying numerous alternatives and the impact of each of the alternatives. Although not clearly stated, it is assumed that the status quo alternative is the selected alternative. The dredge and disposal method in the past has had the benefit of designated sites for spoil placement, which apparently is not the case at this time because the 1969 Dredge Spoil Survey Report has been rescinded. The statement does not specifically define sites for spoil placements; therefore, it is assumed that such spoil placement will depend on existing equipment capabilities and will result in the least adverse impact attainable with this equipment. This leaves the reader in doubt as to what the real impacts will be until such sites can be more specifically defined.

Response: The status quo alternative as discussed in the draft EIS is not necessarily the "selected alternative" for all future operations, although it does represent a discussion of the impacts and effects of maintaining and operating the 9-foot channel project in the future if similar methods as are currently being used would be used in the future. Changes to the status quo method of operation and maintenance would require justification and funding. The District Engineer's recommendations regarding possible changes to the current operations and maintenance activities as a result of the findings of this EIS are contained in the Statement of Findings which is attached. Sites for dredge spoil disposal will be selected on a case-by-case situation as they occur, in a manner similar to current selection methods which utilizes selection of the disposal site which will result in the least adverse impact within limits of the equipment available at the time of dredging. The actual impacts of future dredging would depend on the practices employed and the specific details of each future dredging action. However, the general impacts that would occur are described within the presented information of this EIS.

Comment (24): The sections considering alternatives to status quo dredge spoil placement practices -- both in the general discussions and in discussions for each individual pool -- are highly biased in favor of the status quo. In the final Environmental Impact Statement these sections should be rewritten to reflect a truer picture of both costs and benefits for all the alternatives including the status quo. At the very minimum the following should be done:

1. The status quo alternatives should include not only the economic costs of actual operation but also other costs including those so-called "intangible" environmental costs. Furthermore, the operation costs for maintaining the status quo should reflect the fact that the most efficient and least expensive dredge spoil disposal areas have been used and that future sites will likely involve a higher cost. If these two suggestions were incorporated into the statement, the relative cost of the status quo alternative would show an increase.

2. The alternatives to status quo dredge spoil placement should discuss more than the economic costs. These discussions should also include the benefits that would occur including recreational benefits, wildlife benefits, and so-called "intangible" environmental benefits.

A complete benefits-to-cost ratio, including environmental considerations, should be developed for each alternative to make comparisons more clear and more meaningful.

Response: The Alternatives section was not prepared to be biased in favor of the status quo, but rather to present an overall objective framework within which to judge the various alternatives with respect to their economic, social, and environmental impacts and effects.

The "intangible" environmental costs have been described in general terms of the effects of habitat changes. Although future sites may involve higher costs, these costs are not considered to introduce a significant change in the cost figures presented. The comparability of the costs presented is believed to present a realistic description of the economic costs involved. The "benefits" involved have not been specifically described as benefits, but in more general terms as improvement or degradation to opportunities or habitats. A benefit-to-cost ratio is utilized with regard to original project justification and construction. Consideration of a benefit-to-cost ratio for operation and maintenance activities alone would not be meaningful.

The relative impacts are presented to assist the reader in reaching his own conclusion regarding the relative economic, social, and environmental impacts associated with each alternative.

Comment (20): A major problem with this section, in fact the entire document, is that there is no statement of the objectives. It is impossible to determine if an alternative accomplishes the objectives if those objectives are unknown or only vaguely alluded to.

Assuming that the "modification" alternative is the most reasonable alternative for the project, there are a number of comments to be made on the alternatives within this alternative. An attempt was made to evaluate the "alternative plans" for the pools in the metropolitan area to select an appropriate "alternative plan." For several reasons this attempt was unsuccessful. The first difficulty was that the Statement definitely said these were not the "best or only alternatives" for alleviating the impacts of the operation and maintenance of the channel. It is difficult to select a plan from several examples of possible plans. Why not present the most feasible or reasonable plans for discussion? Another problem was that, although the alternative

plans were designed to alleviate the impacts of the project, there is no indication of the impacts to be alleviated. Also, there is no discussion in detail of the impacts of each "alternative plan" including exact locations although the tables provide some information. As the alternatives are to be weighed according to the impacts it is necessary to know those impacts. The Statement discusses a number of "alternative measures" which were combined in various ways to form the "alternative plan" for each pool. What was the basis for determining the appropriate measures for each pool? Other than cost figures, there is little data presented to aid in the selection of an "alternative plan."

Response: The major objective of the EIS is to comply with the spirit and intent of the National Environmental Policy Act of 1969 and other associated directives. The purposes and objectives of an EIS are discussed in these documents in great detail.

The most feasible or reasonable plan depends on the viewpoint of the individual. We believe we have presented reasonable alternatives to the present method of operation and maintenance of the 9-foot channel project. Undoubtedly other alternatives do exist, and if considered reasonable and appropriate can and should be evaluated. However, the question of which alternatives are "best" or "most feasible" would remain a question of substantial debate and controversy.

The impacts to be alleviated are described in the Environmental Impacts section of the EIS. Each alternative and/or plan has varying degrees of reducing or alleviating these impacts. Reduction of adverse impact on one parameter may be offset by an increase of adverse impact on another parameter.

As described on page 457 of the draft EIS, those alternative measures which had the most widespread and general applications were selected for evaluation in the alternative plans. Generally similar plans with the same basic alternative measures were evaluated in all pools.

Comment (6): Although it obviously would not be realistic to consider total abandonment of the navigation system in favor of other modes of transportation, the Alternatives section should address itself to other modes of transportation as an alternative to navigation, thus, eliminating the need for perpetual maintenance of the navigation channel and the environmental impacts resulting from such maintenance.

Response: The Alternatives section addresses reasonable alternative methods of operating and maintaining the 9-foot channel project, not alternative methods of transportation. The relationship of the operation and maintenance of the 9-foot channel project to other modes of transportation is considered to be included within the discussion of the "Cease All Operation and Maintenance Activities" and the "Provide a Navigation Channel of Lesser or Greater Depth than 9-Feet", as revised in the final EIS.

Comment (10): The draft EIS assumes the continuation of O&M for an indefinite period (although the assumed cumulative effects of various alternatives for O&M were calculated on a 50-year basis). The final EIS should include discussions of alternatives which evaluate the impacts of a phase-out of the navigation project when the functional or economic life of the present lock and dam structures is exhausted, as well as the impacts of changing the primary objective to continue O&M under different authority for recreation, fish and wildlife management purposes.

Response: The 50-year period for future effects was selected as a maximum reasonable time frame over which projections might be considered. Discussion of alternatives dealing with the phase-out of the navigation project when the functional or economic life of the present lock and dam structures is exhausted would be difficult, as the determination of what the functional or economic life of the present structures is, would be exceedingly difficult, and obviously a topic which at this point in time would generate as much controversy and diversity of opinions as the original construction of the project once did. This alternative could be included under the category of an "unreasonable" alternative to present operation and maintenance of the 9-foot channel project. Implementation of many of the alternative measures considered would in essence change the 'primary' or 'secondary' nature of the objectives of the 9-foot channel project. Thus, to a degree, changing of the primary objectives can be considered as included in the present alternatives discussed, even though not expressly stated as such.

Comment (25): Cost projections for the alternative plans are misleading because they tend to assign an inflated cost to all plans other than the status quo. The plan we most favor is removal of the dredge spoil from the floodplain. However, the Corps does not treat this, or any other alternatives, favorably.

For example, in considering removal of the dredge spoil from the floodplain in pool 1, the Corps assigns an astronomical annual figure to the project. However, close examination reveals that the plan includes a stockpile area (in violation of zoning) which could be eliminated; funds for secondary removal, which could be eliminated; funds for additional discharge pipes, which could be eliminated; unspecified "additional equipment", and revegetation and recreation. Revegetation and recreation are not included as costs in other alternatives, although they are more applicable, even necessary, under these other schemes.

Why should there be a stockpile area for dredged material to lie while awaiting movement off the floodplain? Why not simply load it on barges and move the material once? Double handling means increased costs, increased turbidity, increased sedimentation and needless damage to the temporary site. The costs include removal of the spoil for a distance

of "about 25 miles" -- this is not a good average, since closer off-loading facilities can be found at any point on the river. We hope the costs did not include construction of completely new off-loading terminals. We would like to see a breakdown of the costs of the "additional equipment". Do the projected costs reflect the fact that quantities of dredge spoil will diminish yearly if removed from the floodplain? Were the projected costs reduced by subtracting the potential income from sale of the spoil?

Revegetation and recreation should have been listed as a completely separate plan -- not added to the other alternatives. This analysis makes the status quo appear much more economical than it really is -- and all this before the substantial, yet intangible, environmental costs are added to the status quo -- costs which could be reduced by implementation of alternative plans.

Response: The costs presented are not considered to be inflated. They are realistic and representative estimates of what costs would be incurred to implement the various alternatives utilizing the methods which were evaluated. Implementation of any alternative plan would be subject to the merits of that plan, including consideration of zoning restrictions. Revegetation and recreation costs were included as considered appropriate to provide the best utilization of that alternative.

A stockpile would be necessary to provide for orderly removal of the material from the floodplain. Loading material in barges does not remove the material from the floodplain. It must then be unloaded from barges and removed to a suitable disposal site. Every extra handling involves added costs and other associated impacts. Although off-loading facilities may be located closer than twenty-five miles, a suitable disposal site, to which the twenty-five mile figure refers, may not necessarily be located within that distance. If a suitable disposal site were located closer, the costs would be reduced. The costs did not include new off-loading terminals, although in several instances some may be necessary. The breakdown of costs for additional equipment is available in the St. Paul District office for public examination. The projected costs do not reflect any reduction in quantity of dredge spoil if the material is removed from the floodplain. No estimates are available as to how much, if any, reduction in dredge spoil might be affected with this alternative. There was no potential income from the sale of the spoil reflected in the costs which are presented. Any benefits received from the sale of the spoil would offset some of the increased costs.

Revegetation and recreation, as discussed in the EIS, can only be considered as alternative measures, not as separate plans. The analysis does not attempt to misrepresent the costs of the status quo alternative.

Comment (10): The final EIS must be expanded to discuss and evaluate measures which would enhance and restore environmental quality as well as to avoid or minimize adverse environmental consequences. This kind of discussion is mandated for proposed further incremental actions on existing projects by Section 1500.13 of CEQ Guidelines.

Response: Section 1500.13 of CEQ guidelines states that "if the project or program is continued, that further incremental major actions be shaped so as to enhance and restore environmental quality, as well as to avoid or minimize adverse environmental consequences." We believe that sufficient information regarding these potential measures is included in the Alternatives section to properly evaluate any incremental major actions associated with operation and maintenance of the 9-foot channel project which would be undertaken with respect to enhancing and restoring environmental quality as well as avoiding or minimizing adverse environmental consequences.

Comment (1): Regardless of where the spoil is deposited, it is generally acknowledged that much of the material re-enters the dynamic river system. The EIS also indicates that the erosion of dredged material from unstable spoil areas is resulting in the deposition of sediment in sloughs and backwater areas. Therefore, it seems quite probable that dredged spoil is a primary contributor to the deposition in these areas. If, as is stated in the EIS, more studies are needed in order to understand the dynamics of sediment movement, assurances should be provided that such studies will be undertaken before and during significant local O&M activities in areas of high ecosensitivity. Furthermore, the control of the Mississippi River with locks and dams to provide navigation and flood control has reduced the ability of the river to sustain slough and backwater areas. Consequently, the slough and backwater areas which remain become even more valuable to the floodplain ecosystem.

Response: Although it is generally acknowledged that some of the dredge spoil re-enters the dynamic river system, the statement that "much" of it re-enters the system may be an overstatement, since it is not known exactly how much. In some cases it could be substantial and in others it could be minor. It seems probable that dredge spoil is a contributor to sediment deposition in sloughs and backwater areas, but it is not known to what degree. In some cases dredge spoil may be a prime contributor, in others, it may not be involved. Studies referenced in the EIS and identified as needed cannot be assured of being undertaken in the EIS, as the EIS is not in and of itself a source of funding. Any studies conducted would require justification and funding. It is believed that this EIS should provide the basis for justification of the studies. Some sampling and other studies have been undertaken prior and subsequent to issuance of the draft EIS, including commencing sediment sampling stations on tributary streams, revegetation studies on dredge spoil sites, and photogrammetic analysis and mapping of the Upper Mississippi River within the St. Paul District. The attached Statement of Findings summarizes the District Engineer's recommendation regarding proposed actions and studies.

Comment (1): Our primary concern over dredging activities as described in the EIS involves the placement and containment of dredged spoil and the potential effects of this spoil upon the aquatic and terrestrial environment. Past and current practices have had a deleterious impact upon the aquatic and terrestrial environment along the Mississippi River and many of these practices could be corrected with acceptable alternative measures. The Congressional authoritization for the 9-foot channel project allows sufficient flexibility to satisfy environmental concerns and therefore environmentally sound alternatives should be implemented. With the implementation of NEPA, the importance of encouraging environmental harmony in the Upper Mississippi River is not only further emphasized but required.

Response: We concur in the importance of encouraging environmental harmony in the Upper Mississippi River. Although Congressional Authorization allows flexibility to implement some of the alternative measures considered, feasibility, justification and funding are necessary before these alternatives could be implemented. We have several studies now underway to create a better understanding of the problems and the potential solutions to the problems. The Statement of Findings attached to this EIS contains the District Engineer's views on the matter. As appropriate and possible, additional studies will be conducted to define more clearly some of the issues and concerns at hand.

Comment (10): If it is decided that O&M activities will be continued, the final EIS should fully consider the costs and benefits of all primary alternatives to present O&M practices in comparable terms. It is recommended that alternative plans be presented in the following manner, pool-by-pool as well as for the entire project areas:

a. Status Quo
b. Unconfined Disposal of Dredge Spoil in Alternative Locations
c. Confined Disposal of Dredge Spoil in Alternative Locations
d. Removal of Spoil from the Floodplain
e. Sediment Retention in Tributary Watersheds

Such a discussion should take into account all appropriate costs and benefits for all public purposes. This will require a much more realistic analysis of the potentialities of Plans c and e above than was presented in the draft EIS.

Response: Plans (a), (b) and (d) of your suggested list were evaluated in the draft EIS. Plans (c) and (e) were discussed only as alternative measures rather than plans. Your Plan (c), Confined Disposal of Dredged Spoil in Alternative Locations, could be evaluated as well as many other possible combinations. We believe, however, that based on the discussion of confined disposal the reader could make appropriate adjustments to the plans which were evaluated to obtain a comparable evaluation of inclusion of confined disposal. Your Plan (e) Sediment Retention in Tributary Watersheds, is only an alternative

measure to the present operation and maintenance activities and would only tend to reduce the quantity of material dredged, but not necessarily the adverse environmental impacts of present activities. The present alternatives analysis in the draft EIS is believed to be realistic; however, as more specific plans are formulated and evaluated, and as more information is obtained regarding the true merits of the respective alternatives, a better evaluation than is presented in EIS can be made.

Comment (6): Unquestionably, there are other alternatives to the present O&M program that are worthy of being considered in the statement. New barge design, contract dredging, better regulation of reservoir storage to combat low flows, possible changes in structure design, and change in location of structures are other possible alternatives. These are broad concepts that should demand intensive study. Unfortunately, one gains the impression from reading the statement that a predecision was made to justify and defend the status quo. If such is true, this decision undoubtedly hampered constructive and imaginative thought of those personnel responsible for preparation of the impact statement.

Response: Although countless other alternatives to the present O&M program undoubtedly exist, we believe that we have considered the majority of reasonable alternatives that would tend to reduce or alleviate adverse impacts of the present activities. No attempt was made to justify or defend the status quo activities.

Comment (6): Foremost of those alternatives worthy of extensive consideration is an analysis of other means of transportation. Some minor references are made to comparative energy uses of the various modes of transportation, but they are not treated as alternatives to the present method of O&M. Even the alternative for dredge spoil removal by private dredgers or by sand and gravel companies was not analyzed fully.

Response: Other means of transportation are briefly considered in the "Cease All Operation and Maintenance Activities" and "Provide a Navigation Channel of Lesser or Greater Depth than 9-Feet" alternatives in the final EIS. Dredge spoil removal by private dredgers would result in similar impacts to those evaluated and presented, except that the costs would probably be greater.

Comment (10): Congress has authorized the 9-foot navigation channel, but it also enacted the National Environmental Policy Act of 1969 requiring Environmental Impact Statements to provide a means by which the public, including Congress, can make wise decisions before committing to major actions affecting the human environment. As noted in Principal Finding No. 3 of these comments, the draft EIS assumes that the continuation of O&M on the project is an accepted fact. This is contrary to NEPA and affords the public, including Congress, no opportunity to weigh the "no action" alternative at all. The discussion of the

alternative, "Cease All Operation and Maintenance Activities," should be treated as though continuation of the activity is a proposal. Thus, the alternative becomes a "no action" alternative and should be given the same rigorous examination as any other alternative. All identifiable beneficial and adverse environmental, social and economic effects should be noted and quantified. Such a discussion is essential to the balance of the statement and the fulfillment of NEPA requirements.

Response: The "Cease All Operation and Maintenance Activities" alternative has been revised and expanded upon in the final EIS. Sufficient detail regarding the alternative has been presented to provide the reader with an understanding of the magnitude of the impacts and effects of this alternative. Also, refer to the Comments/Responses contained on pages 564 and 565.

Comment (18): Page 335, Third Paragraph, First Sentence - The statement is made that consideration of the alternative of discontinuing the operation and maintenance of the 9-foot channel is not considered as a reasonable alternative to the present operation and maintenance activities since it would have such a great impact on the socioeconomic and natural setting. The alternative of discontinuing this project rests with Congress, not with the Corps of Engineers. The Corps should then provide pertinent facts to the Congress in order to make a rational decision. The major impacts which could be attributed to the abandonment of the project would be the loss of investments in existing facilities both as a part of the navigation project itself and related port facilities along the river. One obvious alternative to barge traffic would be rail traffic, and unless the terminal facilities were presently developed in such a manner that they could be served by rail, significant additional investments would have to be made to either modify these facilities or to relocate them, Thus, the overall question of the environmental impact of this proposal is largely dependent upon the competition between rail and barge traffic. If rail traffic became more competitive due to a proper cost accounting of total environmental costs related to spoil disposal for the navigation project, the overall negative impact on the local economy could be significantly reduced.

Response: Comment noted.

Comment (8): The alternatives of ceasing all operation and maintenance activities, or providing a navigation channel of lesser depth than 9 feet, are not acceptable to the interests of navigation on the Upper Mississippi River. If dredging is not maintained, or a channel of less than 9 feet in depth was maintained, we feel that there would be an increased potential for groundings and accidents due to the low water channel. Thus, the potential for environmental degradation due to spills of oil and hazardous substances would increase. This potential impact wasn't covered in the statement. If dredging isn't maintained this season, the Coast Guard may have trouble getting it buoy tenders into position to place buoys marking what channel does exist. If the buoy system is not maintained, the potential for accidents and spills will increase.

Response: The referenced section of the final EIS has been revised to reflect the nature of your comment.

Comment (18): Page 336, First Paragraph, Second Sentence - The operation and maintenance of a navigation channel with lesser depths would reduce the frequency at which maintenance dredging had to be performed. This would be a result of the decreased reservoir capacity leading to a decreased trap efficiency. A reduction in the depth of the channel would require barges of lesser draft or smaller loads on existing barges. This would probably lead to greater costs and fuel consumptions per ton mile.

Response: Although operation and maintenance of a navigation channel of a lesser depth than 9-feet would probably alter the frequency with which maintenance dredging had to be performed, it would not necessarily reduce the frequency of dredging, especially not due to the reason cited in your comment. Reservoir capacities as utilized in trap efficiency computations would not be significantly changed by reductions in the depth of channel maintenance dredging. Since no significant changes in reservoir capacities would occur, the trap efficiency would not be noticeably affected.

A reduction in the channel depth, however, could require either small barges and/or small loads on existing barges and possibly greater costs and fuel consumption per ton-mile.

Comment (10): The controversial nature of potential impacts is not a legitimate reason for considering O&M of a channel other than a 9-foot channel an unreasonable alternative. This should be fully discussed in the final EIS.

Response: This statement has been revised on page 234 of the final EIS.

Comment (10): Inadequate consideration was given in the draft EIS to possible methods of retaining sediment within the tributary watersheds. It should be evident to everyone that control of sediment at the source (erosion control) is a most desirable alternative, if feasible, for all public interests associated with the river. The four categories of measures which would serve to retain either suspended sediment or bedload, or both are:

a. land treatment (soil conservation practices on individual farms);
b. channel stabilization in upstream areas (grass waterways, gully control structures and grade stabilization structures);
c. channel stabilization in main channels of tributary streams (streambank stabilization and grade stabilization structures); and
d. sediment entrapment (in farm ponds, reservoirs and sedimentation basins).

The effectiveness of these measures on a watershed basis would, of course, depend on the choice of method(s) and the degree of application. It is

agreed that land treatment alone would not greatly affect the amount of bedload sediment, i.e., the dredging requirement. However, it would be of great benefit to the preservation of the backwater areas and main pools. Thus, a combination of the above measures would be required to achieve a high degree of control for both types of sediment. This systematic approach could be used either as a primary or complementary method of sediment control. For example, a 50 percent reduction in the delivery of bedload sediment would result in a comparable reduction in dredging requirements. Likewise, a 50 percent reduction in delivery of suspended sediment would double the life of the pools and backwater areas, if other factors remained the same.

Response: The Corps of Engineers is in complete agreement with the sentiments expressed in this comment with regard to the desirability of retaining sediment at the source. Soil conservation practices would not appreciably affect 9-foot channel O&M requirements since these practices would not affect the amount of bedload sediment to any great extent. Therefore, since the primary area of concern in this EIS involves the environmental impacts related to O&M activities, a program of soil conservation practices could not be considered a viable alternative or adjunct to present O&M methods as was, for example, bank stabilization measures which would have a greater potential for reducing maintenance dredging and its attendent adverse impacts. However, because soil conservation practices could significantly reduce backwater sedimentation, the Corps supports the efforts of all agencies concerned with the resulting adverse effects and within whose purview soil conservation practices would fall.

Comment (1): The alternatives of increased spoil disposal flexibility, revegetation of disposal sites, commercial use of dredged spoil, watershed land treatment and development of recreational facilities have great potential in reducing adverse social, environmental and economic impacts. These alternatives should receive full consideration in the decision-making process and should be incorporated whenever possible in maintenance dredging practices to alleviate adverse impact. These alternatives should be considered singly and in combination in future studies to determine their maximum environmental and economic public benefit.

The implementation of a more flexible disposal program should incorporate the variability and compatibility of several different plans, i.e. selective spoil placement, remote disposal, central disposal and floodplain removal, for a given pool area. The overall acceptance of such a program will be dependent upon its ability to avoid and minimize the inherent adverse impacts of dredging and disposal practices.

Response: Comment noted.

Comment (1): Watershed land treatment should be considered in areas such as the Chippewa River where there is a substantial conveyance of sediment loads to the Mississippi River (see Exhibit 63). Attacking some of the causes of the sedimentation problem instead of its effects could substantially reduce dredging impacts. As stated in the Minnesota Environmental Policy Act, Section 9, "proper land-use practices can conserve soil resources, provide for flood prevention, expand wildlife resources, prevent impairment of dams and reservoirs, assist in maintaining navigation,protect the tax base and provide areas for recreational development."

Response: Watershed land treatment if implemented to sufficient degrees could probably reduce dredging requirements and associated impacts. It is doubtful that the degree of these reductions could be classified as substantial.

Comment (10): The estimate of a 15 to 30 percent reduction of sheet erosion through the land treatment measures mentioned in this paragraph is too low. Extensive research on soil losses by the Agricultural Research Service shows that the following average reductions in field soil losses are possible:

(a) Contouring ------50%
(b) Strip Cropping---75%
(c) Terracing -------86% to 95%

Therefore, with "an accelerated program of such land treatment measures," an overall reduction in sheet erosion, i.e., production of suspended sediment, on the order of 50 to 75 percent should be possible. Thus, the sediment problem in the Upper Mississippi Valley provides dramatic evidence that the control of sheet erosion is of major benefit to the general public, through reduction of sediment delivery to the Mississippi River. It also provides long-range productivity benefits to the landowners.

Response: The field soil loss reductions used in the comment may be valid for an intensively and extensivly cultivated watershed suddenly subjected to a comprehensive program of soil conservation measures. However, it is unreasonable to assume that these same reductions could be achieved in the navigation pools' drainage basins with their diversity of land uses.

Although sheet erosion of cultivated areas is the primary source of suspended sediments, uncultivated areas also contribute a significant quantity of suspended materials. Therefore, although contouring, terracing, and/or strip cropping cultivated areas in a watershed may greatly reduce the sediment yield of the treated acreage, the sediment yield of the entire watershed is reduced by a smaller percentage. Furthermore, many cultivated areas already are being treated by one or more land treatment measures. These areas would not show the same percentage reduction in sediment yield as previously untreated areas. Also, it is unreasonable to assume that all cultivated areas would be included in even a comprehensive soil conservation program. This too would reduce the potential sediment yield reduction. We feel that the 15-30 percent reduction in sediment yield estimated by the Minnesota Area Office of the Soil Conservation Service is a more realistic figure than those quoted in the comment.

Comment (18): Page 340, First Paragraph, Last Sentence - Such an accelerated land treatment program should be quantified. In other words, how much would it cost to initiate an accelerated program to reduce sheet erosion in the study area by 15 to 30%? Such a study should include cost estimates.

Response: Since land treatment measures of the soil conservation type would not appreciably affect 9-foot channel O&M requirements, they could not be considered as viable alternatives to present O&M practices. Therefore, they did not receive the same detailed consideration as other promising alternatives.

The availability of the type of information needed to prepare a reliable estimate of the cost of a comprehensive land treatment program was not determined for this EIS. The information required would include the acreage of cultivated land that might be expected to participate in such a program, the acreage already utilizing one or more land treatment measures, the degree of sediment yield reduction desired for any particular parcel of land, the types of measures that would apply to the selected acreage, etc.

Also refer to previous Comment/Response.

Comment (18): Page 341, First Paragraph, First Sentence - The improper location of sedimentation basins could cause more environmental damage on the streams where they were located then they would prevent downstream.

Response: Comment noted.

Comment (13): Page 342 - Several P.L. 566 watershed projects in Wisconsin have been completed in Buffalo, Pepin, and Pierce Counties. The major project purposes were watershed protection and control of erosion and associated land voiding and depreciation. These projects demonstrate an effective means of reducing erosion and its source. Not only does agriculture benefit from this type of project, there are other benefits to the public related to roads and bridges, as well as social, aesthetic, and environmental aspects. Although changes in stream regimen may occur because of a reduced volume of sediment reaching the tributaries to the major rivers and conveyed to the Mississippi, the results of such control should be accounted for in a reduction of dredging costs and preserving the valuable 9-foot navigation channel and associated fish and wildlife. It is suggested that any erosion and sedimentation study should include P.L. 566 watershed projects as a means to control gully erosion and associated sedimentation.

Response: We concur that P.L. 566 watershed projects should be included in any erosion and sedimentation study as a means to control gully erosion and associated sedimentation. The benefits of these types of projects to the 9-foot channel should be credited toward the projects to the degree quantifiable.

Comment (10,18): The pessimistic statement in the second paragraph that some land treatment measures are prohibitively costly, subject to adverse social reaction, etc., is a very questionable conclusion which requires documentation. Without cost estimates and other information no one outside the Corps can draw an independent conclusion.

It is hard to believe that the long-term effects of such a land treatment program would not be beneficial even though it may be cheaper now to let it erode and dredge out the sand in the Mississippi River. From the long-term standpoint, such a proposal may be the most economically feasible.

Response: The Corps of Engineers agrees that a comprehensive land treatment program could have enormous long-term benefits. However, it is important to recognize that there are several indeterminable factors that make it impossible to quantify and compare costs and benefits with any degree of reliability. For instance, in a period of decreasing agricultural surpluses coupled with increasing world demand for agricultural products, a major land use policy decision would have to be made regarding the trade-off between agricultural uses which promote a high sediment yield and nonagricultural uses which could be selected to yield comparatively little sediment.

Rather than basing estimates on unfounded assumptions or appearing to present policy in areas not within the Corps' purview this alternative is discussed in qualitative terms. Unfortunately, the commentor selected to quote out of context. The full quote is: "The cost of implementing some of the measures would be prohibitively high for individual landowners or watershed organizations and may be unjustifiably high when compared to the benefits. Also, there might be adverse social reaction toward efforts to control land use." This was intended to suggest that potential difficulties on the local level might make it impossible to develop a successful program of comprehensive watershed land treatment measures, i.e., a program capable of generating a high degree of participation in order to achieve a substantial reduction in sediment yield. For instance, indiviual landowners and watershed organizations might not be able to afford the investment required for a sufficiently extensive and intensive program. Alternately, they might be able to afford it, but feel that their share of the costs exceeds anticipated local benefits, downstream benefits notwithstanding. A successful program would almost certainly required State and/or Federal funding and land use regulations, the latter possibly making this alternative unpalatable to many local interests.

Comment (2): We are very pleased to see the consideration you have given watershed land treatment as an alternative, and feel that your staff should be complimented. We believe that this is the first dredging proposal which we have reviewed which has incorporated this consideration. We are not in total agreement with the discussion because we feel that it tends to be biased against land treatment as an alternative, just as we no doubt tend to be biased in favor of it. An example of this bias is the statement "However, the cost of implementing some of these measures would be prohibitively high for individual landowners or watershed organizations and may be unjustifiably high when compared to the potential benefits." As you know, such measures now receive public subsidies on the basis that the public benefits, just as dredging is subsidized or financed wholly by the Government.

Similarly, negative statements include "trying to institute more watershed land treatment measures in an emerging area of food shortages -- would probably be difficult," and "savings . . . might not balance the expenditure." No basis is presented for these conjectures and we feel that just the opposite is more probably ture.

Response: It is indeed unfortunate that a dearth of reliable data prevented a more comprehensive quantitative analysis, including a complete evaluation of the watershed land treatment alternative. As discussed in the EIS, the benefits from watershed land treatment measures can transend the dredging question, affecting a multitude of fields, including agriculture, transportation, health and the environment. Hopefully, if future revisions of this EIS are necessary more and improved data will be developed in the interim and will be available for inclusion in a revised or updated EIS. Also refer to previous Comment/Response.

Comment (10): Since costs or benefits are not quantified, there is no legitimate basis for concluding that savings from a comprehensive watershed land treatment program "might not balance the expenditures that such a program would entail." These kinds of unfounded statements are subsequently used as a basis for arbitrarily dismissing watershed land treatment as a potentially worthwhile measure for arresting sedimentation in pool and backwater areas.

Response: See response to the previous two comments.

Comment (10): Page 342 - Grade stabilization structures are intended for stabilization and preservation of gullies in upstream areas, not to "curtail soil losses." Subsoils often contain coarse sediments. (This is acknowledged in the following paragraph.)

Response: Small grade stabilization structures (essentially drop structures) are commonly used to decrease grades and keep soils from being transported away from the source area (see Upper Mississippi River Comprehensive Basin Study). Large stabilization structures with detention features are used on gullies to prevent further downcutting and to act as a settling basin for sediment entrapment.

Comment (18,10): Page 343, First Paragraph, Second Sentence - Conversely, watershed land treatment measures would be expected to decrease runoff rates thereby decreasing the bedload transport in gullies and streams.

Response: In small watersheds, the decrease in bedload transport capability due to the reduction in runoff rates would tend to offset the increase in bedload transport capability due to the reduced influx of suspended materials. The net effect could vary from watershed to watershed depending on the relative effectiveness of these two instances.

Comment (18): Page 343; Second Paragraph, Third Sentence - In general, watershed land treatment measures would in fact reduce both the quantity of runoff due to increased infiltration and the peak volume of runoff due to an increased time of concentration in the watershed. Therefore, it would be expected that increased scouring of gullies and streams would not necessarily result nor would the extent of scouring be equal to the lesser amount of sediment inflow attributed to reduced sheet erosion.

Response: Although peak flows would be reduced and delayed in small watersheds, this attenuation effect would be lessened considerably in large watersheds which might in fact experience an increase in peak flow depending on the relative changes in timing of flows from tributary watersheds.

The sediment load would probably experience a net decrease in quantity as a result of watershed land treatment measures. In other words, the riverbed and riverbank erosion caused by the decreased influx of suspended materials would probably generate a smaller increase in coarse bedload intervals. Since O&M activities are related to the quantity of bedload rather than to the total sediment load, this alternative may result in a temporary increase in maintenance dredging, the adverse impacts of which could offset the environmental gains from reducing the quantity of suspended sediment.

Comment (10): Page 343 - The statement implies that content of suspended sediment in flow significantly affects bedload transport capability, such a cause and effect relationship is highly questionable and requires documentation. It is wrong to say that land treatment will increase channel erosion. This is an unsupported conclusion based on speculative propositions.

Response: The relationship between suspended sediment and bedload was discussed with Soil Conservation Service representative and corroborated by several sources, including the authoritative book, Open-Channel Hydraulics, by Ven Te Chow.

Comment (18): Page 344, second paragraph, first sentence - This statement is made that watershed land treatment efforts upstream from dams on tributaries would probably be wasted as far as their effect on reducing maintenance dredging requirements. This, of course, is an obvious statement. The logical choice would be to institute land use controls and land treatment practices downstream from the dams on the tributaries. A combination of the existing tributary dams along with a reduction of sediments introduced to the stream should lead to a reduction in bedload in the Mississippi River itself. While the channel may develop a greater capacity to scour itself out in response to a reduced sediment inflow, the significance of this change is not clear. The "hunger" of water for sediment is generally related to the suspended or collodial sediment load and not to the coarser fraction which is carried along as bedload. A reduction in the inflow of coarse grained sediments would not necessarily lead to increased channel erosion of any great significance. In addition, the continuing deposition of bedload within the channel indicates that at the depth called for in the navigation project, the river is presently carrying a load of sediment greater than its capacity. If the present system were in relative equilibrium, maintenance dredging may not be required at all. Therefore, the argument that reduction of sediment inflow would automatically be compensated for by increased channel scour appears to be incorrect. In addition to reducing the sediment load in the Mississippi River, watershed land treatment measures could be expected to improve the quality of smaller tributary streams.

Response: Our studies indicate that the relationship between bedload influx and river regime has been accurately portrayed. A river adjusts its parameters - cross section, slope, roughness - to the sediment load. How these parameters adjust to a decrease in bedload sediments at any particular location could vary, of course, but we maintain that there probably would be an eventual reduction in dredging requirements (not necessarily equal to the reduction in bedload influx).

Comments (4,6): Page 344 - The statement indicates here that the adoption of any watershed land treatment measures in headwater areas would probably have little or no effect on the amount of dredging..." necessary for maintenance. On page 94, however, one of the reasons listed for the decline in dredging trends in the St. Paul District is the "Bank stabilization and land treatment measures instituted particularly within the last 40 years... ." It appears that the conflicting views presented in these two sections should be resolved.

Response: The reader must consider the qualification, "in headwater areas" in the first referenced statement.

Comment (10): Page 344 - The statement that reduction in bedload would increase streambank scour applies only if scour extended to greater depths than is now obtained by dredging, or if channel meandering increased.

Response: Comment noted. The EIS discussion was intended to call attention to the possibility of undesirable bank erosion from this resource. A river adjusts to reduced sediment influx by changing cross section, slope, and/or roughness. Of course, how these hydraulic parameters react at any given location can vary, making it important to be aware of possible adverse consequences.

Comment (11): Page 344 - second paragraph, first sentence - Supporting data should accompany such a significant and conclusive statement.

Response: Comment noted. The text which follows the statement in question provides a qualitative discussion based on available hydraulic, hydrologic, and sediment transport data and expertise. We agree that more supporting data would be desirable. As more and better data are obtained, future revisions of the EIS, if necessary, can incorporate the latest findings.

Comment (10): Page 344 - The second paragraph, implying that bedload movement in tributary watersheds is already well controlled, except in lower portions of these streams, is very questionable. Specific evidence should be offered.

Response: See response to previous comment.

Comment (10): Page 344 - Agree that sedimentation and bank stabilization on tributary streams would be an effective means of reducing the amount of bedload sediments entering the river.

Response: Comment noted.

Comment (10): Page 345 - The draft statement tantilizes the decision-makers with the possibility of reducing dredging and its attendant effects in pools 4 (below Lake Pepin), 5 and 5A by stabilization of terraces along the lower Chippewa. Yet the document is silent on the costs and benefits of such a measure. This provides no basis for comparison of this potentially important alternative. This deficiency should be corrected in the final EIS.

Response: The terraces of the Chippewa River and its tributaries were not surveyed because the extent of their contributions to the sedimentation problem was not fully and immediately comprehended. This, of course, made it impossible to estimate the cost of stabilizing these terraces. Similarly, the inadequacy of existing sediment data for these watersheds made it impossible to accurately assess the potential benefits of this measure. Sediment data is starting to be gathered to assist in assessing this alternative.

Comment (18): Page 346, first paragraph, first sentence - The alternative of using watershed land treatment practices is discounted. It appears that this alternative has not received the full study which it deserves; rather, the desire to continue along existing institutional guidelines has become evident at this point. The benefits from land treatment go considerably beyond a simple reduction in the frequency of dredging of the navigation channel, and such practices may be desirable in their own right independent of the navigation project.

Response: We agree that the benefits of watershed land treatment go beyond the possible reduction of dredging of the navigation channel and that they may in fact be desirable in their own right independent of the navigation project. However, as an alternative which would significantly reduce the adverse impacts associated with the operation and maintenance of the navigation channel, it cannot be considered effective without implementation of other alternative measures which consider the actual activities of dredging and dredge spoil disposal.

Comment (6): Watershed land treatment cannot be dismissed simply because it would cost more than dredging. Watershed land treatment would provide more benefits than just to relieve dredging and, therefore, the costs cannot be directly compared.

Response: Refer to previous Comment/Response.

Comment (10): Page 346 - In the list of potential benefits from land treatment, benefits due to reducing sediment deposition in backwater and main pool areas is not included. This is clearly a major environmental benefit.

Response: The last item on page 346 of the draft EIS does list "reduced rate of degradation of biologically-sensitive sediment deposition sites" as a benefit. This would include both backwater and main pool areas. This would be an environmental benefit.

Comment (18): Page 346, second paragraph, first sentence - The draft Environmental Impact Statement indicates that implementing a comprehensive regional land treatment program would be impossible. Certainly an incentive and penalty program in cooperation with Federal and State governments would be extremely fruitful and would not necessarily have adverse effects on agricultural production. In fact, such a program may improve agricultural production. History would seem to indicate that proper erosion control measures have led to more productive farming not less productive farming. Any loss of acreage would be more than offset by increased production on the remaining acreage. It is also indicated that the total economic effects of a comprehensive land treatment program could not be ascertained without more detailed studies. This is another indication that the draft Environmental Impact Statement is deficient in the areas of significant adverse impacts and viable alternatives. Such a land treatment program would be expected to result in a decrease in environmental losses.

Response: The EIS does not indicate that implementation of a comprehensive regional land treatment program would be impossible, but rather that under the current trends and laws, and recognizing past experience, implementation of such a program would be exceedingly difficult. With appropriate laws and restrictions governing farming practices and watershed treatment such a program might be more feasible.

Comment (41): Page 347-351 - There is potential for problems in sediment control of the Wisconsin River since even though the sediment input of the Wisconsin is greater than that from the Chippewa, the majority of the sediment is carried into the Rock Island District as bedflow in the Mississippi. Cooperative planning between the St. Paul District and the Rock Island District will be necessary to handle the sediment.

Response: Comment noted.

Comment (10): Page 347 - The statement that "each use would prefer to have the sedimentation process of the river handled or treated in a different manner" is presumptious and should be eliminated.

Response: The referenced statement is believed to be generally correct. It is retained with a minor revision.

Comment (6): It is stated correctly that there are a variety of opinions on how sedimentation should be controlled. However, this is true only for control measures within the floodplain. It should be pointed out that there is general agreement among concerned agencies that the sediment should be prevented from entering the river. Treatment measures on or along the Chippewa River may be entirely reasonable.

Response: Concur. The referenced statement has been revised in the final EIS on page 241.

Comment (6): The discussion of emergent wing dams should include a description of the impacts of the sand trapping between consecutive wing dams. Such sand trapping channelizes the river drastically as evidenced in the St. Louis District. The accretion of sand to levels above normal pool heights creates dry land in areas that formerly were high quality aquatic habitat. The possible increase in flood levels resulting from new structures also should be discussed. Such navigation structures appear to be responsible, to a degree, for the increasing flood heights as seemingly demonstrated in the flood records of the St. Louis District.

Response: Both positive and negative aspects of this alternative would have to be weighed carefully before seriously proposing adoption. The aesthetically and environmentally damaging effects from emergent wing dams might make them generally unacceptable in the Upper Mississippi River basin. At certain locations, however, localized conditions might make emergent wing dams preferable to existing maintenance practices. The effect of wing dams on flood stages could vary depending on the extent of their usage, sizes, effects on sedimentation patterns, and impact on river hydraulics. In the St. Paul District, for instance, wing dams appear to have contributed to a reduction in flood stages.

Comment (10): Page 348 - Assuming that "the river" includes backwater and off-channel areas, the statement that "proper location of wing dams, closing dams, and sediment barriers could be used to reduce the amount of sediment entering the river..." is confusing. To clarify the discussion, it should be noted that the effect of sediment barriers is to reduce sediment inflow to the entire river; the effect of wing dams and closing dams is to direct deposition in the area of the main channel.

Response: The actual effects of any sediment deposition control structure depends on its location, function, type, etc. A sediment barrier other than a wing dam or closing dam could be constructed within the river to control sediment deposition. The entire description as provided is believed adequate to convey the thoughts which your comment provided.

Comment (18): While the location of emergent wing dams and closing structures may make the main channel more hydraulically efficient, they would be expected to also have an adverse effect on backwater areas, marshes, and sloughs. Examples of this type of structure on the Missouri River provides an insight into the environmental impact of this alternative.

Response: Comment noted.

Comment (10): Pages 348-349 - While placement of closing dams "across the feeder channels to the backwater areas to keep the water in the main channel" is probably technically feasible, it is so ecologically irresponsible that it should not even be discussed in the final EIS. It is simply not a reasonable alternative.

Response: The actual specific effects and relative merits of any closing dam would have to be evaluated on a case-by-case basis. Generally speaking, installation of closing dams would cause adverse environmental impacts as noted on page 350 of the draft EIS, however there may cases where environmental benefits could be obtained by use of such a measure, and as such, this action merits discussion as a possible alternative to certain aspects of the present method of operation and maintenace of the 9-foot channel project.

Comment (18): Page 350, paragraph 1, first sentence - Thus, this alternative would result in essentially the same effect as present dredge spoil disposal practices of depositing large amounts of dredge spoil material adjacent to the main channel.

Response: The types of structures referenced would definitely cause isolation of many backwater areas due to their construction. The present dredge spoil disposal practices may tend to isolate some backwater areas by reducing the flows through inlets to these backwater areas, however the amount and magnitude of this impact is not fully known.

Comment (18): Page 350, second paragraph - It is stated that "Trapping bedload sediment from tributary streams could greatly reduce the amount of coarse material reaching the Mississippi River." Again it is stated that such a program would probably reduce the amount of maintenance dredging needed, but it is not known for sure how much. This is another indication that the draft Environmental Impact Statement should provide additional quantification of this alternative.

Response. - Additional information regarding this alternative is not currently available. However, based on the information presented in Section 2 of this EIS regarding sediment and on the complete discussion of this alternative and also of watershed land treatment, further quantification of this alternative is not felt to be necessary at this time. Additional information for this alternative is desirable though, and if available for any possible future revisions or updatings of this EIS should be included.

Comment (10): Page 350 - Third paragraph suggests that a sedimentation basin would not be feasible by saying costs "may" exceed the benefits and "could" cause other problems, without giving cost estimates or other supporting data. Trapping would reduce coarse sediment.

Response: The actual feasibility or desirability and determination of associated impacts of a sedimentation basin would depend upon the results of more detailed studies.

Comments (10, 18): Inadequate consideration was given in the draft EIS to the alternative of Confined Disposal. Several locational alternatives were discussed, i.e., Selective Placement, Remote Disposal, and Central Disposal, but unconfined disposal was assumed in each of these cases. The more basic consideration is the choice between unconfined and confined disposal. Various locations for dredge spoil disposal could be used with either of these methods. Rejection of Confined Disposal as a beneficial alternative because "none of the material dredged...is considered to be polluted" and "no Congressional authorization currently exists" is unwarranted. The Chief of Engineers' office acknowledges other reasons for using Confined Disposal of Spoil, including fish and wildlife management and cost savings, and states that the practice is now in effect on more than 200 Corps Projects. (Source: Technical Report H-72-8, Chief of Engineers, November 1972).

Response: The differences between the environmental impacts of confined and unconfined disposal relate primarily to the areas adjacent to the primary dredge spoil area. The location of the dredge spoil area creates the basic impact of conversion of the existing aquatic and terrestrial wildlife habitat to sandy areas. This conversion of basic habitat types, including the location, type, and extent of the conversion, if felt to be of greater significance than the alleviation of impacts caused by using unconfined disposal practices. Confinement of dredged spoil is not rejected as a beneficial alternative, but rather is not considered as one of the alternatives which have the greatest potential for reduction of adverse impacts associated with O&M activities of the 9-foot channel on the Upper Mississippi River within the St. Paul District (refer to Exhibit 244). There may be cases where this alternative could be suitably used to reduce adverse environmental impacts of O&M activities, however, these would have to be determined on a case-by-case basis. And, just as in the referenced cases where confined disposal is practiced, proper justification would be required to include containment facilities in the dredge spoil disposal plan.

Confined disposal measures and subsequent impacts and effects could be added to the various alternative plans to determine the overall impacts and effects of the plans, which are aimed primarily at alleviation of the basic locational impacts.

Comment (12): The EIS states that according to Federal regulations, none of the dredge spoil could be considered as polluted. No information regarding such regulations, making comparison to tests performed on the dredge spoil, are given in the EIS. In addition, no information is available regarding analysis of undisturbed dredge material or analysis on the dredged spoil is given. Additional information required includes nutrient levels, pesticide-herbicide levels, COD, BOD, oil, grease, and metals concentrations. Core analysis of future dredging locations would help to make a proper assessment possible. Such information in backwater areas could be helpful in assessing the impacts of prior activities.

Response: The referenced section in the EIS has been revised. Additional information regarding the before, during and after dredging conditions is needed for a more detailed evaluation of the effects of dredging on water quality and associated impacts. A water quality sampling program of this type is being initiated. Also refer to the Statement of Findings.

Comment (18): Page 352, first paragraph, third sentence - The use of sand dikes for spoil containment structures are obviously less expensive than other containment structures, but they are also more vulnerable to rupture or collapse. They could easily rupture and allow the spoil material to discharge into adjoining wetland areas. One accidental break in the dike could negate any benefit which may accrue from confinement of the spoil material. Riprapping of spoil sites would also provide good fish habitat. The high cost of riprapping may encourage removal of the spoil material from the floodplain.

Response: With proper design, sand dikes should not rupture easily. However, they would probably be more susceptible to certain types of failures than would other types of containment structures. The environmental impacts caused by a rupture in a sand dike would vary considerably depending on the specific of the failure; whether such a failure would negate any benefit accrued would depend on the specific case. Riprapping of spoil sites would provide good fish habitat only on submerged riprapped areas which are adjacent to waters suitable for survival of fish. The high cost of riprapping would not necessarily encourage removal of the spoil material from the floodplain, as other factors besides the cost of riprapping enter into the merits of the alternative of removing dredge spoil from the floodplain.

Comment (10): Page 355 - The statement, "a confined site might actually be larger than an unconfined site," would apply only to the above-water portion and only for rather special conditions. In general, confined disposal would take less space, much less if 10-20 feet high.

Response: The statement referenced could also apply to the below-water portion and could apply to many normal conditions rather than to only special occasions if containment of small volumes would be required. Containment facilities constructed to a height of greater than 10 feet would require extensive areas for dike construction and if constructed for a single disposal operation would require special safeguards to preclude possible dike failures.

Comment (10): Page 355 - The fine particles are "carried beyond the immediate boundaries of the disposal site, effectively extending the area affected by the dredging operation." On page 316, the draft statement says, "The turbidity generated during maintenance dredging spreads beyond the disposal site... ."

Response: This statement has been revised on page 246 of the final EIS.

Comment (10): The "use of a confined disposal area would reduce the amount of fine material being carried into backwater areas..." As noted on pages 351-352, "This will permit fine materials to settle out and be retained onsite rather than being discharged into the waters surrounding the site."

Response: The use of a confined disposal area would reduce the amount of fine material being carried into backwater areas only if properly designed, with sufficient retention time provided for the dredged slurry and if no dike failures are sustained. The use of "could" is felt appropriate in this context.

Comments (10, 18): Page 357, Second Paragraph, First and Second Sentences - It is stated that current Federal regulations require the confinement of dredge material when it is determined to be polluted. There is no indication that the guidelines established by the U.S. Environmental Protection Agency for analyzing the chemical parameters of bottom sediments was used. EPA guidelines call for the evaluation of the following parameters: percent volatile solids, oil and grease, COD, total nitrogen, total phosphorous, lead, mercury, and zinc. Of these parameters, only two are indicated on Exhibit 187. There is no indication whether the methods for testing the water quality before, during and after dredging followed standard methods. We would also like to know who determined that the dredge spoil materials were not polluted since the EPA normally makes this determination.

The requirement for contained disposal facilities is limited to the Great Lakes as stated in 33USC, section 1165a(h) "This section, other than subsection (i), shall be applicable only to the Great Lakes and their connecting channels." 33USC, section 1165a(i) states that "The Chief of Engineers, under the direction of the Secretary of the Army, is hereby authorized to extend to all navigable waters, connecting channels, tributary streams, other waters of the United States and waters contiguous to the United States, a comprehensive program of research, study, and experimentation relating to dredge spoil. This program shall be carried out in cooperation with other Federal and State agencies, and shall include, but not be limited to, investigations on the characteristics of dredge spoil, and alternative methods of its disposal. To the extent that such study shall include the effects of such dredge spoil on water quality, the facilities and personnel of the Environmental Protection Agency shall be utilized." The content of this draft Environmental Impact Statement appears to fall far short of the requirements stated in this subsection.

Section 101(b) of the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500) states "It is the policy to the Congress to recognize, preserve, and protect the primary responsibilities and rights of states to prevent, reduce, and eliminate pollution, to plan the development and use (including restoration, preservation, and enhancement) of land and water resources ..." Section 313 of the Federal Water Pollution Control Act Amendments of 1972 states "Each department, agency, or instrumentality of the executive, legislative, and judicial branches of the Federal government (1) having jurisdiction over any property or facility, or (2) engaged in any activity resulting or which may result, in a discharge or runoff of pollutants shall comply with Federal, State, interstate and local requirements with respect to control and abatement of pollution to the same extent that any person is subject to such requirements, including the payment of reasonable service charges." Chapter 147.015(3), Wisconsin

Statutes, defines pollutant as "Any dredge spoil, solid waste, incinerator residue, sewage, garbage, refuse, oil, sewage sludge, munitions, chemical wastes, biological materials, radioactive substance, heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharged into water." Tentative regulations for Federal dredging projects in navigable and ocean waters as stated on page 6113 in the Federal Register (volume 39, number 34-Tuesday, 19 February 1974) states "Section 404 of the Federal Water Pollution Control Act (33USC1344, 86 Stat. 816) authorizes the Secretary of the Army, acting through the Chief of Engineers, to issue permits, after notice and opportunity for public hearings, for the discharge of dredged or fill material into navigable waters at specified disposal sites. The selection of disposal sites will be in accordance with guidelines developed by the Administrator of the Environmental Protection Agency (EPA) in conjunction with the Secretary of the Army. Furthermore, the Administrator can prohibit or restrict the use of any defined area as a diposal site whenever he determines, after notice and opportunity for public hearings, that the discharge of such materials into such areas will have an unacceptable adverse effect on municipal water, supplies, shellfish beds and fishery areas, wildlife or recreational areas." Thus, it would appear that in order to determine if the dredge spoil materials violated water quality standards, it would be necessary to follow EPA guidelines for the analysis of bottom sediments and to obtain an opinion from the Environmental Protection Agency as to whether the bottom sediments could be considered as being polluted.

Many of the existing spoil deposit sites are located in the floodway in open water areas and wetlands. Section 30.12, Wisconsin Statutes, prohibits the placement of fill materials below the ordinary high water mark of a navigable water. Wisconsin Administrative Code, NR 115 and 116, prohibits the placement of fills within the floodway. These regulations are intended to protect the public's interest in navigable waters, fish and wildlife resources, and to protect water quality. It would appear that Wisconsin regulations for controlling fills below the ordinary highwater mark should be given greater consideration since the Federal Register (Volume 39, No. 34 - Tuesday, 19 February 1974) states on page 6114 that "State regulatory laws or programs for classification and protection of wetlands will be given great weight."

The indiscriminate deposition of dredge spoil materials within the waters of the State of Wisconsin conflicts with State law and State policy for the protection of fish and wildlife resources, wetlands, and public rights to navigation. Even though dredge spoil material was to be removed from the floodplains of Wisconsin, the resources of this State would still feel the effects of spoil deposition in the upstream areas of Iowa and Minnesota since the waters of the Mississippi and the fish and wildlife resources

therein do not follow State boundaries. The larger particles from upstream dredging projects would be deposited in spoil disposal sites; however, the finely grained particles and colloidal material would be carried downstream to settle in backwater areas. As a result, the fish and wildlife resources and water quality of the State of Wisconsin would continue to be adversely effected.

Response: The referenced paragraph has been revised on page 247 of the final EIS.

With reference to the "research, study, and experimentation" to be carried out regarding dredge spoil (33 USC, section 1165a(i), a comprehensive "Dredged Material Research Program" is currently underway at the U.S. Army Engineer Waterway Experiment Station, Vicksburg, Mississippi, and is being conducted in compliance with the referenced statute. This EIS is using and has used information from the "Dredged Material Research Program" as it becomes available. This EIS is being prepared in compliance with NEPA, however, and not in compliance with the statute referenced above.

Due and full consideration is given to State statutes to the maximum extent possible. However, whenever State statutes impose unreasonable or impractical restrictions to operation and maintenance activities, the requirements of these statutes may not be fully met. Operation laws and regulations, and to the maximum extent possible with State, interstate, and local rules and regulations. The tentative regulations for Federal dredging projects which are referenced were only draft regulations at the time of the draft EIS and were not to be followed until finalized. Currently many of the requirements of the proposed regulation are being followed. This referenced draft regulation was finalized and is effective as of 22 July 1974. Measures are being taken to assure full compliance with this regulation.

As referenced, the river system cannot be considered solely upon what is happening in the State of Wisconsin. Alternative solutions to operations and maintenance problems, as well as the impacts and effects of operation and maintenance activities must be considered over the effective area of influence for each respective parameter considered.

Comment (27): We reject the bizarre notion presented on page 357 of the impact statement that the Corps only has the authority to dump spoil by the side of the channel.

Response: No such notion is either stated or implied.

Comment (10): Page 358 - Erosion of spoil materials is "contributing to the partial closure of guts or sloughs feeding fresh water into backwater areas," as noted on page 265.

Response: The erosion of dredged spoil materials is suspected to be involved in partial closure of guts or sloughs. However, the statement referred to on page 265 of the draft EIS, states that dredged material is contributing to isolation of backwater sloughs, rivers, lakes, and ponds from the main channel along with natural movement of sediments and floodplain construction. The portion of dredge spoil that is contributing to this closure or isolation could be either by direct placement, subsequent changes in velocity patterns, or by erosion of dredged material. The degree to which erosion of the dredged material is implicated in such closure is not known, and as such, the statement "may be contributing" is felt to be more correct than the suggested change.

Comment (10): Page 359 - Many of the benefits associated with minimizing secondary movement noted in the discussion of revegetation also apply to confined disposal.

Response: The benefits referred to regarding minimizing secondary movements of dredged spoil could also be applicable to confined disposal, depending upon the type of containment facility used. Use of steep sloped sand dikes as discussed on page 354 of the draft EIS could tend to increase the likelihood of secondary movement of sand compared to the existing situation.

Comment (1): Revegetation of dredged spoils appears to be a viable alternative. It is recommended that future detailed studies be undertaken to determine the feasibility of this alternative. A major environmental problem as stated in the EIS is the movement of dredged spoils by erosion. This alternative has great potential for partially correcting this problem in an effective way, both environmentally and economically.

Response: Additional study is underway regarding the feasibility of revegetation of dredge spoil areas. Contracts have been let with River Studies Center, University of Wisconsin, La Crosse, Wisconsin, to study the characteristics of revegetation experiements in pool 8. The Statement of Findings and the Summary of Alternatives in the final EIS contain information regarding the potential of this alternative to alleviate adverse environmental impacts.

Comment (18): Page 359 - second paragraph, first sentence - The value of stabilized spoil sites may be considerably less than what it had been originally, particularly if it had been aquatic habitat. Just how significant this new habitat would be for increased wildlife is a question which must be answered particularly in light of the frequency of addition of new spoil to the site. Natural plant succession on the spoil areas is extremely slow due to a lack of nutrients, moisture, and stability. In many cases, natural revegetation cannot occur due to repeated deposition of spoil. These disposal sites serve as a constant source of sediments for the downstream areas particularly during periods of high water. The use

of top soil and fertilizer on the spoil sites has been considered to lend fertility to the sterile sand areas. However, if the spoil area is exposed to high water before the vegetation is firmly established, the erosive force of the water could carry the topsoil downstream. This could provide an additional source of sediments and nutrients to backwater areas. Therefore, the timing of such procedure is extremely important.

Response: Concur. It is believed that most, if not all, questions contained in the comment will be answered following the analysis of results from current revegetation studies.

Comments (12, 18): Revegetation of existing spoil piles in an attempt to reduce secondary movement of spoil material would seem to have favorable impact reducing the need for redredging and reducing the damage to the backwaters. However, the application of fertilizers and/or sewage sludge would raise questions of leaching of nutrients to the river and the possibility of removal of these nutrients by floodwaters rendering the attempts fruitless as well as pollutional.

Response: Revegetation of dredge spoil areas, including the application of nutrients to facilitate vegetative growth, would require more study to determine the full impacts of such action. In any event the impacts would vary on a case-by-case basis.

Comment (18): Page 363 - Care should be exercised in the selection of seed for plantings. Use of exotic species, southern strains of commercially grown native seed, and species incompatible with recreation use (i.e. triple awn grass, sand bur, Exhibit 190) may all have undesirable consequences.

Response: Comment noted.

Comment (18): Page 364, second paragraph, third sentence - The use of an asphalt emulsion for mulching of dredge spoil sites has been considered; however, the use of such an emulsion may constitute a possible water contaminant. Various other techniques have been discussed which would render the existing spoil deposit sites less damaging to the environment. The alternative of remote disposal and selective placement have also been considered for future dredging operations; however, these methods have not considered whether they would be in conflict with State statutes or floodplain zoning regulations. Little attention has been paid to the possible removal of existing dredge spoil sites from the Mississippi River floodplain.

Response: The actual desirability of use of an asphalt emulsion for mulching of dredge spoil sites would require further consideration prior to implementation. Included in this consideration would be the possibility of such a emulsion constituting a possible contamination of the water.

The alternatives of remote disposal and selective placement are discussed in a later portion of the EIS. Consideration of State statutes and floodplain zoning regulations was given in the evaluation of these and other alternatives to the extent that the least environmentally damaging disposal areas would be selected within the limits available for that alternative. Consideration would be given to abide by State laws and regulations to the maximum extent possible if these alternatives were to be implemented.

Removal of existing dredge spoil sites from the floodplain was not evaluated, primarily because this was not believed to be a reasonable alternative to the existing operation and maintenance of the 9-foot channel project. This alternative may be less environmentally desireable than those currently evaluated.

Comment (10): Page 366 - Vegetation of spoil sites, if done with species especially selected for recreational purposes, would not necessarily cause "loss of potential recreation sites."

Response: Referenced statement has been revised in final EIS on page 253.

Comment (18): Page 366, item i - Dredge spoil material should not be deposited on the inside of river bends since these areas usually are deep and provide good fishery habitat. Due to erosion and scouring, this spoil material would wash away in a very short time. The placement of dredge spoil material on the lower end of main channel islands would also contribute to secondary movement and the gradual closing off and isolation of backwater areas.

Response: The inside of river bends and lower ends of main channel islands are subject to less erosive velocities than are the outside of river bends and upper ends of main channel islands, respectively. As noted on page 362 of the draft EIS, these are factors which should be considered when establishing vegetative cover. The actual impacts of dredge spoil placement in these areas would have to be determined on a case-by-case basis.

Comment (18): Page 367, item d - It would seem fairly easy to determine the amount of material which would be eroded from dredge spoil sites particularly since the volume of material is known from the size of the dredge cut. The rate of settling and the amount of material which has been eroded could be periodically determine over time by using standard surveying techniques. Since the accusation that the dredge spoil material does erode away is not new, it seems rather incredible that the Corps has not undertaken the study of at least a few dredge spoil sites to determine if there is indeed secondary movement and erosion of dredge spoil sites. Field examinations at dredge spoil sites does show that there is erosion of the spoil by water and wind. It has been brought to our attention that unquantified estimates by the Bureau of Sports Fisheries and Wildlife reveal that up to 70 percent of the dredge spoil material may be lost to erosion by wind and water.

Response: No detailed on-site studies have been made or initiated to date to determine the amount of material eroded from dredge spoil sites. However, photogrammetric analysis of aerial photographs has been initiated to determine the long term effects of dredge spoil disposal on the Upper Mississippi River system. Portions of this analysis will possibly involve secondary movements of dredge spoil.

As noted in the EIS, erosion of the dredged spoil by both wind and water does occur, however, reliable estimates of the amount that has been eroded are not available. Although undoutedly in some cases much of the dredge spoil has been eorded, there are conversely some cases where very little dredge spoil has eroded. More information would be needed to make further estimates. The reliability of the estimates made by the Bureau of Sport Fisheries and Wildlife as to the amount of dredge spoil which has eroded to which you allude, cannot be determined without more specific information as to where and how the evaluations were made. Additional studies along this line will undoubtedly be conducted in the future and when available can be incorporated into any future revisions or updatings of the EIS.

Comment (18): Page 368, first paragraph - We would like to know why there is no established program to encourage vegetative growth on dredge spoil sites since this is an established and accepted land conservation practice.

Response: Studies of types of vegetation which could be utilized successfully on dredge spoil disposal site are currently in progress. As noted in the full discussion of this alternative measure, there are many factors to consider prior to implementation of a full scale program.

Comment (18): Page 370, first paragraph - The problem of revegetation would still exist in areas where there is continued redeposition of spoil material. In these instances, vegetation would just get started about the time that it would be spoiled upon again. As a result, revegetation would not even be a short term solution.

Response: Refer to referenced paragraph for completion of statement. Revegetation may be considered a short term solution if combined with other measures. In areas, where there is a continual redeposition of spoil material, the amounts and frequency of spoil deposition would play a key role in determining what other measures would be necessary to effect a short term solution to the problem.

Comment (18): Page 370, Second Paragraph, Fourth Sentence - The relocation of dredge spoil at fewer but larger spoil sites would require a close examination of any such sites. In many instances, valuable backwater habitat would be destroyed rapidly by direct dumping instead of slowly from secondary movements of spoil by river currents and wind. Backwater habitat relatively undisturbed by developments and barge traffic would be traded off in order to protect main channel areas which have been heavily influenced both by commercial and recreational development.

Response: Comment noted.

Comment (10): Page 369 - If hand sowing of seed is cheaper, it would seem reasonable to use such a method at large as well as small sites.

Response: Hand sowing would have two major faults on large areas. Primarily, hand sowing efficiency would soon be outmatched by mechanical means on increasingly larger areas. Secondarily, use of mechanical means for planting certain species, for example, prairie grasses, would insure constant seed depths and a greater potential for uniform germination.

Comment (10): Page 372 - Planned disposal with buildup of sites to "finished dimensions" is cited as a possible worthy measure; it is really a confined disposal technique. Yet, the Corps does not identify confined disposal as an "alternative measure having greatest potential for reducing adverse environmental impacts" in Exhibit 223 for any segment of the river.

Response: The planned disposal with buildup of sites to "finished dimensions" as sited refers to unconfined disposal techniques and involves planning of a disposal area over many years with some other ultimate use intended for the site after its planned use as a disposal area is completed.

Comment (18): Page 371, Second Paragraph - The call for coordination and constructive roles in the placement of dredge spoil material is fine in theory, except that State and Federal natural resource agencies have attempted to cooperate with the Corps of Engineers in the placement of dredge spoil material for the past forty years with little success. During these past forty years, there has been a continued loss of wetlands, aquatic habitat and terrestrial habitat to dredge spoil disposal.

By asking for an Environmental Impact Statement, it was hoped that the Corps of Engineers would provide the necessary leadership and foresight which is required in order to complete an acceptable Environmental Impact Statement. However, the Corps has sought to defend the status quo alternative and has not attempted to provide a clear and concise description of the adverse and beneficial impacts of the operation and maintenance of the 9-foot channel project. It is intimated that the State resource agencies have been uncooperative, are not understanding of the problems, and misunderstand the dredging situation and effects on the river. By the same token the Corps of Engineers has been not entirely understanding of resource management problems and profess complete ignorance in the Environmental Impact Statement on the effect of dredge spoil disposal on the river.

The Corps' reluctance to provide a complete and adequate description of the adverse and beneficial impacts of the project and to provide the necessary detailed data for decision making can only lead one to believe that they too are uncooperative. Since the operation and maintenance of the 9-foot channel project is the Corps of Engineers' responsibility, it would seem essential that the Corps would provide the necessary leadership and foresight in order to bring everyone together and to propose some solutions.

Response: The Corps of Engineers had initiated work in 1972 for preparation of the EIS in compliance with the intent and spirit of the National Environmental Protection Act. The interpretation of the draft EIS as a means of defending the status quo is an opinion held by your agency. However, additional studies are being conducted in an attempt to clarify the applicability and feasibility of alternatives to the status quo in an attempt to reduce the adverse environmental impacts of the current activities. The beneficial and adverse impacts of existing O&M activities has been stated based on the available facts and information. Where this information has been found to be insufficient to clearly identify the magnitude of the impacts, additional study has been recognized as being necessary. Some of this additional work is currently underway. The Statement of Findings for the final EIS indicates the conclusions drawn from the studies conducted during preparation of the EIS, including recognition of the comments received.

Comment (18): Page 373, Third Sentence - It is felt that the timing of dredging operations so as not to disturb sensitive biological functions such as spawning activities and waterfowl nesting sites is an important consideration.

Response: Comment noted.

Comment (19): The remote disposals or removals of spoil from the floodplain could result in a substantial increase of truck traffic in the work area. This increase volume, with the probable spilling of the spoil, would cause safety problems along with the accelerated deterioration of highway pavements and roadbeds.

Response: Comment noted.

Comment (18): Page 377, First Sentence - The reopening of side channels which have become blocked with dredge spoil material and sediments could also have a beneficial environmental impact by providing more flow to backwater areas.

Response: Comment noted.

Comment (11): Page 377 - Loss of wildlife and fish habitat are factors that may contribute to justification for increased handling costs.

Response: Comment noted.

Comment (18): Page 380, Second Paragraph - In general, removal of spoil material from the floodplain is the best alternative environmentally since it involves the smallest acreage of habitat destruction due to its noncumulative nature. It is usually as cheap or even less expensive than the cost of permanent sites on the floodplain which would require the longest transport distances for spoil.

Response: Rating of the full environmental effects of this alternative must include an evaluation of the final disposal. Indicating that this is the "best" alternative environmentally is an opinion of your agency. The purpose of the EIS is not to select the best alternative, but to

provide information to assist the decision-maker in evaluating the true effects and impacts of an action on man's environment, and the alternatives to this action and their respective effects and impacts.

Comment (18): Page 382, Third Paragraph, Fifth Sentence - We would like to know how the handling and loading cost of $0.25 per cubic yard for the rehandling of materials was arrived at.

Response: This cost was estimated to represent a reasonable cost which could be incurred to rehandle the material. It was based on general information available regarding cost for movement of the type and quantity of material being considered.

Comment (6): Inflated statistics and use of data not applicable to the Mississippi River distort the facts within the statement. The addition of $2.25 per cubic yard for removing the spoil from the floodplain does not appear appropriate. This figure is the cost of moving the material from stockpiles after it has been removed from the river. This is not a cost that the Corps of Engineers would assume and cannot be applied to cost estimates for their dredging activities (Exhibits 195 through 208 - Footnote 6). If the Corps plans to truck every cubic yard of spoil 25 miles, this should be discussed. Apparently, $.55 per cubic yard also is added to the cost, supposedly since it will cost the Rock Island Corps of Engineers District more to dredge (page 412). No data are presented to substantiate the $.55 figure or the addition of it to the costs of the St. Paul District's dredging. This further supports our recommendation to develop a single statement for the entire authorized project from St. Paul Minnesota, to Cairo, Illinois.

Response: The costs are presented as preliminary realistic estimates of implementing the respective alternative methods of handling the dredge spoil. The costs would be incurred either by the Corps or some other agency, and as such represent the charge to the taxpaying public. These preliminary estimates are subject to change as more specific information is obtained regarding specific alternatives and also as price levels and interest rates change.

Comment (4): Page 383 - The information presented in this section is conflicting and often confusing. It appears that the dredging and handling costs, as indicated by the statement, are considerably higher than those incurred by private sand and gravel companies. These companies, while operating under similar conditions, remove millions of cubic yards of sand and gravel from the river to storage areas at costs ranging from $0.75 to $2.00 per cubic yard. It appears that these figures are significantly lower than the $1.97 to $6.35 per cubic yard quoted as the cost in the statement. In addition, this section should include sufficient information on the cost and number of additional transportation facilities necessary for spoil removal to justify the conclusions reached.

The dredging and handling costs indicated (page 383) are well above those of private sand and gravel companies. These companies handle millions of cubic yards of sand with hydraulic equipment and move it to stockpiles off the floodplain. Their range of costs is from $.75 to $2.00 per cubic yard based on a 1973 study by the Bureau of Sport Fisheries & Wildlife. This

can be compared to similar operations by the Corps with costs estimated at $1.40 to $5.80 per cubic yard. These figures are from cost estimates on page 383, less the cost of moving the material 25 miles and without the prorated increase in costs from the Rock Island District. If these cost estimates are accurate, consideration should be given to private contracting as an alternative.

Response: The conditions encountered by most private sand and gravel companies is not comparable to channel maintenance dredging requirements, as such costs for these different operation conditions can vary significantly. Refer to the previous Comment/Response. Private dredging contractors would probably encounter comparable costs (if not greater) to perform the work as evaluated in the respective alternatives. The comparability of the costs which your agency has quoted as estimates for private sand and gravel companies to stockpile sand and gravel and costs estimated for implementing the various alternatives is not known. More specific information would be needed to determine what degree of comparability exists.

Comment (18): Page 383, Eighth Sentence - It is mentioned that the cost for removal from the floodplain includes the removal cost only and does not indicate the cost and availability of land for ultimate disposal. It should also be noted that nowhere is there any cost figure included for possible economic returns for resale or reuse for the ultimate public benefit.

Response: The possibility of commercial uses of the dredged material and possible economic returns were discussed on pages 442 to 449 of the draft EIS.

Comment (6): There is nothing in this statement to support the contention on page 384 that the biological life of the river will necessarily be short as a result of natural sedimentation, since removal of 70 percent of the bedload by dredging offsets much of the natural sedimentation. Specific contributions of backwater filling by bedload and suspended sediments should be addressed.

Response: There is no statement on page 384 of the draft EIS that contends that the biological life of the river will necessarily be short as a result of natural sedimentation. The specific rates of filling in of the backwater areas are not known, and hence the specific contributions of bedload and suspended sediment are not known. Information on sedimentation was presented in the draft EIS on pages 74 to 94.

Comment (18): Page 384, First Sentence - It is intimated that the removal of dredge spoil from the floodplain may not do any good if other factors are causing the filling of backwater areas. This statement appears to be a rationalization for not quantifying the adverse effects of the project itself. It is logical in this instance that if the adverse effects of the project were evaluated, the main cause of blocking flow to the backwater areas would be found to be the deposition of dredge spoil.

Response: Although it may appear logical to your agency that deposition of dredge spoil is the main cause of blocking flow to backwater areas, we have no documented evidence that this indeed is the case. Without more information than is currently available, it would be very difficult to arrive at the same conclusion. More information is needed to determine what the rate of filling of backwater areas would be, both with and without the placement of dredged spoil in the floodplain.

Comment (18): Page 384, Second Paragraph, Second Sentence - We wonder how it is possible to calculate unit costs for removal of dredge spoil material from the floodplain when no specific suitable or desirable areas for the deposition of dredge spoil out of the floodplain were identified. It would seem that the unit costs which were arrived at would be completely useless until this was determined since the requirements for additional plant, hauling distances, and rehandling of dredge spoil materials may be entirely different under a more factual situation.

Response: Although no specific suitable or desirable sites were identified for final deposition out of the floodplain, it was reasonably assumed that a suitable site would exist within a distance of 25 miles from the stockpile area. In some cases sites could be located at shorter distances and in other cases at longer distances. Depending on the specific conditions at each site, the costs may vary from those shown. However, the cost figures presented are believed to be a reasonable estimate of the true cost of implementing such an alternative, and are provided to give the decision-maker some comparable information upon which to evaluate the various alternatives.

Comment (6): Although removal of spoil from stockpiles will require additional trains, barges or trucks, the statement does not provide information concerning the additional transportation facilities needed. Therefore, there is insufficient data to support conclusions reached against removal of stockpiled sand from the floodplain.

Response: The conclusions stated in this section have been revised in the final EIS.

Comment (39): Discussions on page 385 and the statistics contained in Exhibit 192 would seem to make a case for removing dredge spoil from the floodplain for upland disposition. Based on the distance material would have to be hauled, and in the light of current rail car shortages, the 412 cars per day estimate for the 6-month operation would involve a staggering percentage of the gondola car fleet available in this region.

Response: The referenced discussion and exhibit do not intend to make a case for removal of the dredged material from the floodplain, but present specific information relative to the alternative. Your statement regarding the amount of railroad gondola cars needed is noted.

Comment (18): Page 385, Second Paragraph, First Sentence - Again, it would seem necessary to identify these areas where minor changes in dredge operating procedures and where minor modifications of transportation facilities would be necessary since this would tend to decrease the unit cost for removal of dredge spoil from the floodplain.

Response: The identification of areas where only minor changes in dredging operating procedures and transportation facilities would be helpful to assess this alternative. However, as noted in the EIS, "most major dredging locations would require extensive expansions of existing dredge plant capability and a large amount of construction of auxiliary handling facilities in stockpile areas, including railroad sidings, etc." Since most major dredging locations would require extensive changes, and these dredging locations are most likely causing the greatest adverse environmental impacts, these areas should receive primary consideration in evaluating the referenced alternatives. In cases where only minor modifications are necessary to existing procedures and facilities, the increase in unit costs to remove the material from the floodplain over the unit costs of the current practices would not be as great as the increase in unit costs where major modifications would have to be made.

Comment (10): Pages 385-386 - It would seem that at least part of the cost of handling dredge spoil removed from the floodplain would be offset by monies received through sale of the material for commercial use.

Response: Comment noted. Refer to discussion on commercial use of dredged material on pages 442 to 449 of the draft EIS.

Comment (18): Page 386, First Paragraph, Second Sentence - This sentence is a subjective argument which implies that protection of the Mississippi River environment is not worth the additional cost of removal of dredge spoil from the floodplain. On the other hand, if environmental benefits were included and considered in this alternative, the removal of dredge spoil from the floodplain may be the best alternative.

Response: The referenced paragraph has been revised in the final EIS on page 263.

Comment (18): Page 391, Third Paragraph, Last Sentence - This sentence is very vague and is in need of clarification.

Response: This statement has been revised in the final EIS on page 266.

Comment (12): In the discussion on dredge cutterheads, additional information would be useful in supporting the conclusions given. Specific information regarding the varying rates and efficiencies would be useful in making an assessment. All data available on cutterhead related turbidity including the 1973 study eluded to in the EIS and dredge efficiency without the use of a cutterhead should be presented.

Response: Specific information regarding the referenced rates and efficiencies is not readily available. There is no specific information relative to cutterhead turbidity available for dredging activities in the St. Paul District. The 1973 study referenced in the EIS was on dredging related turbidity as stated, and did not include specifically separable information on cutterhead turbidity. This study can be found in the Environment Impact Assessment Report, Pool 8, prepared by North Star Research Institute, and is also discussed in Section 4 of the final EIS. Based on the available information, the statements as presented in the draft EIS are felt to be justified and adequate to provide a reasonably accurate view of the cutterhead activities and impacts, and related alternative measures for considering a modification to the cutterhead.

Comment (18): Page 393, Third Sentence - This statement does not agree with the statement on page 316, second paragraph, second sentence, where it is stated that "Turbidity generated at the cutterhead is generally regarded as insignificant." On page 395, it stated that "The amount of turbidity caused by the cutterhead could be expected to be minor due to the sandy nature of the material being dredged throughout most of the St. Paul District."

Response: The referenced statement is correct as stated in the draft EIS. Although "the cutterhead activity unavoidably generates turbidity," and this turbidity "may have adverse impacts on the aquatic ecosystem," the turbidity generated at the cutterhead in most of the St. Paul District is considered to be insignificant or minor. The resultant impacts of this turbidity on the aquatic ecosystem would also be expected to be on a similar level as the amount of turbidity generated.

Comment (18): Page 394, Second Paragraph, First Sentence - It is stated that "A basic modification to the cutterhead operation such as either a swivel cutterhead or cutterhead shield could probably reduce the amount of turbidity being produced and result in a more efficient dredging operation." While on page 395, third paragraph, first sentence, it is stated that "Any basic modification to the cutterhead might result in changes of plant efficiency, but would probably not reduce significantly the turbidity at the cutterhead and any associated adverse impacts."

Response: Comment noted. The key word in the second sentence is "significantly."

Comment (18): Page 395, Second Paragraph, Third Sentence - The ecology of the navigation channel is not well known enough to state that it is less significant in terms of plant and animal life than backwater areas. For some species, such as the pallid and the paddle fish, the main channel is important to their continued existence.

Response: It is recognized that there are species such as the pallid sturgeon and the paddlefish which depend on the deep waters of the main channel for their continued existence. However, the overall ecological significance of the backwater areas in terms of plant and animal life is by far more important than the navigation channel. This is supported by biological data collected in the summer of 1973 as part of an Environmental Assessment Contract with North Star Research Institute. The assessment reports prepared for each of the pools in the St. Paul District were made available to the general public.

Comment (4, 6): Page 396. This section should discuss the possibility of using passing lanes in selected locations, which would reduce the need for maintaining the entire project at the present width.

Response: This is addressed in the final EIS on page 271.

Comment (4, 6): Since barges stop and start at relatively few areas, the possibility of reducing the 13-foot depth of overdredging in given areas should also be considered and discussed.

Response: Overdepth dredging is accomplished primarily to allow a reasonable period between maintenance requirements. Starting and stopping of barge tows is only one of the reasons which can significantly reduce the period between maintenance requirements. Further consideration in reductions of overdepth dredging would require additional study.

Comment (10): Pages 397 and 410-414 - The final EIS should discuss what effect the Corps' transfer of the DREDGE ROCK ISLAND out of the Rock Island District in 1958 has had on the dredging capability and the maintenance dredging requirements within the St. Paul District portion of the 9-foot channel project. We note that overdepth dredging to 13-foot depths is one result, allowing a "cushion" because the DREDGE THOMPSON no longer spends all its time in the St. Paul District. Also, the opportunity to reduce the pumping rate and increase the operating radius of the Dredge by as much as one mile has been inhibited by the transfer of the Rock Island to Mobile Engineer District (as the DREDGE COLLINS). The Corps should comment on the possibility of replacing the DREDGE ROCK ISLAND as an alternative to expansion of the capabilities of the DREDGE THOMPSON.

Response: If each District had the capability of the DREDGE THOMPSON, various areas could be considered for reduction in overdepth dredging. Existing funding and workload requirements do not appear to justify two dredges. Cost and lack of workload were major facts in elimination of Rock Island's dredge. The actual effects of this transfer is not known at the present, and although interesting, is not essential to the understanding of the effects and impacts of project operation and maintenance.

Comment (6, 18): Since overdredging to a depth of 13 feet accounts for a major part of the dredge material (over 40 percent, page 397), it warrants closer and more detailed description. If overdredging is required at every dredged site, this should be made quite clear. The statement also should indicate whether some reaches need to be dredged only rarely, and are located such that tugs normally pass through at a uniform speed so that "windrowing" is rare. From the statements given on page 397, it seems possible that overdredging could be reduced for nonproblem reaches, but that it is necessary at other locations. A site-by-site study of reaches requiring dredging may result in the adoption of a different policy on overdredging and, if so, should be included in the statement as an alternative.

Response: Overdredging a depth of two feet is the general practice, as noted in Section 1, "Description of Major Federal Action." As noted in Section 6, "Alternatives," the number of areas in the St. Paul District where reductions in overdepth dredging and subsequent reductions in the adverse environmental impacts of the O & M activities might occur are not known. Additional study is necessary to determine the full effects of considering reductions of overdepth dredging and might result in a change in overdepth dredging policy. The referenced study cannot be considered a reasonable alternative although a study would be desirable. Refer to Summary of Alternatives in Section 6 of the final EIS and to the Statement of Findings regarding the recommendation of such a study.

Comment (18): Page 400, Item c - The draft Environmental Impact Statement indicates that certain things may require the purchase of another dredge in addition to the THOMPSON. This is quite possible, since the THOMPSON has taken over the dredging for two districts. One piece of equipment should handle one district at the most if it is to do a proper job. Thus, the THOMPSON has been overextended to the point where it is performing far beyond its capabilities to do the job properly.

If the Corps of Engineers were permitting work of this nature by private contractors and requiring the things that would be required of all permittees such as confinement, riprapping, proper effluent control, there is no way that a contractor with a plant of this type could possibly perform the amount of dredging which the THOMPSON performs during one season. Conversely, if the THOMPSON were to do its work, as the Corps requires private contractors to do it, these private contractors could do the dredging for less cost than the Corps, and they presently have the capability to do so.

Response: The DREDGE THOMPSON is not performing beyond its capabilities to do the job properly. The addition of a new 12-inch hydraulic dredge in the Rock Island District will assist in handling the workload previously assigned solely to the THOMPSON. However, this reduction of workload on the THOMPSON will not necessarily result in improved dredging methods by the THOMPSON, as many other factors are involved. The actual workload versus dredge capability and efficiency is more meaningful a comparison than the determination that one piece of equipment should handle one District at the most in order to do a proper job.

Letting of the dredging work accomplished by the Corps of Engineers out to private contractors has been much more costly in the past and this trend is expected to be indicative of future trends. Use of confinement, riprapping, etc. would increase the costs of dredging whether it would be accomplished by the THOMPSON or a private contractor. The work cannot be let out to a private contractor until the workload exceeds Government plant capability. Few private dredging firms have the capability to handle the type of work implied in your comment.

Comment (18): Page 401, Second Sentence - It would seem appropriate that the spots where the amount of dredging could be reduced should have been located in this draft Environmental Impact Statement.

Response: More detailed study would be required to determine these locations. Refer to Comment/Response before the previous one.

Comment (4, 6): Page 403 - Many natural openings into backwater areas are less than the 125 feet listed for the "narrow" entrance to Murphy's Cut; these smaller openings are also important to the well being of fishery resources in the backwater habitats.

Response: Comment noted. The referenced statement has been revised in the final EIS on page 273.

Comment (18): Page 403, Second Paragraph, Fourth Sentence - The reason some channels do not allow the passage of shallow craft is that the closing structures are close to the surface of the water. These closing structures also restrict the movement of water into the backwater areas and allow for increased sedimentation and stagnation.

Response: Comment noted.

Comment (27): We must protest one theme that runs throughout the impact statement. The point is made a number of times (for example on page 406)

that the system of locks and dams on the Upper Mississippi was authorized entirely to provide a 9-foot navigation channel, and that that authorization does not extend to other benefits. This position is, of course, technically correct, but it does not follow that the Congress intended simply to turn over the River Valley, with all of its human and other inhabitants, to the Corps of Engineers for manipulation at will in the single-minded drive to achieve a 9-foot navigation channel. The nine-foot project was clearly intended to be integrated into the existing life of the River, and was not expected to subdue all reasonable and humane restraints that normally govern the affairs of man.

Response: This Environmental Impact Statement is concerned with the operation and maintenance activities associated with the 9-foot channel project as related not only to navigation, but to other benefits as well, including recreation and fish and wildlife values. The activities are discussed in the context of the authorities granted to the Corps of Engineers by Congress. These authorities include the responsibility to preserve, protect, and enhance other resources in addition to navigation. The Corps must work within its authorities and until these authorities are changed, modified, or extended, the Corps cannot engage in other activities which are currently outside its authorities. The Corps recognizes the necessary integration of the 9-foot channel project into the entire Upper Mississippi River valley environment and has made efforts to coordinate its work with the agencies and interests that have primary responsibility for the other portions of the total environment to ensure that to the best of its capability other interests are affected as little as possible.

Comment (18, 6): Page 407, First Sentence - We would like to know how the Corps of Engineers could have dredged 314,000 cubic yards of material from the bed of the Chippewa River in May of 1965, since "additional statutory authority would be needed for dredging for other than maintenance of the navigation channel."

Response: The referenced "statutory authority" phrase has been modified in the final EIS. However, special provisions by the Chief of Engineers allowed for a "one time" pilot effort. The result did not justify any continued effort at the time.

Comment (18): Page 406, First Paragraph, First Sentence - Since the concerns for the environmental and recreational aspects of the operation and maintenance of the 9-foot channel have been around for at least ten years, it would appear that the Corps has had adequate time to have prepared detailed studies and to have sought out appropriate alternatives for correcting these problems. It appears that the lack of authority to do anything more on the Mississippi River, other than to dredge the channel and dispose of the dredge spoil materials in backwater areas, is being used as an excuse. If the Corps would have been acting in good faith and would have been concerned about the environmental aspects of the operation and maintenance of the 9-foot channel, we would have assumed that they would have made a report to Congress explaining the problems and asking for

additional appropriations and for additional authority. But as stated on the bottom of page 406, "As yet, this and other recommendations have not resulted in a change in such authority." This can only be interpreted to mean that the Corps has no concern for the continued degradation of the Mississippi River environment.

Response: The St. Paul District has pursued scientific review of environmental effects of dredge disposal and alternate disposal methods as genuine environmental concern was established.

Comment (18): Page 409, Second Paragraph, Fourth Sentence - It is indicated that the Philadelphia District is doing studies on the dredging of materials to appointed disposal sites with special equipment; however, it is also indicated that the technique may not work on the Mississippi River since it is only 9 feet deep instead of 40 feet deep such as the Delaware River. Discounting this possibility seems to be premature due to a lack of factual information. In our opinion, a 9-foot channel depth would not be any great obstruction to such a procedure. Certainly, barges and equipment which operated on the Delaware River would also be viable for use on the Mississippi River.

Response: It is stated in the draft EIS that "Many factors would have to be considered in determining the feasibility of incorporating a comparable type of barge system in the St. Paul District," and also that "The effects and impacts of implementing such a system would depend on its actual feasibility and applicability." The use of this system was not discounted for the St. Paul District. The specific barges and equipment which operate on the Delaware River would not necessarily be suitable for use on the Mississippi River in the St. Paul District because of significantly different conditions as discussed in the EIS. A similar concept might be an engineering feasibility for the St. Paul District conditions; however, all potential effects and impacts of such a system would have to be considered before any rational decision could be made.

Comment (4): Pages 411-414 - The cost figures presented for the various alternatives should be coordinated with those prepared by the Rock Island District, Corps of Engineers, which are significantly lower.

Response: The costs referenced for the various alternatives have been coordinated with the Rock Island District. The costs for comparable alternatives utilizing pipeline transport with the DREDGE THOMPSON are essentially the same. The St. Paul District recognized increased operating costs for dredging in the Rock Island District if the DREDGE THOMPSON was utilized only in the St. Paul District; a comparable cost was not recognized in the derivation of the Rock Island District cost data. We believe that this additional element of cost accurately represents the true cost incurred for the appropriate alternative evaluated. The context within which the respective cost estimates are used by either District

serves the purpose of providing a relative comparison of alternatives. The cost estimates presented in the St. Paul and Rock Island reports are not directly comparable when taken out of context.

The issue of apparent discrepancies in cost estimates for the various alternatives between the St. Paul District and Rock Island District was also mentioned at the Public Meeting in La Crosse, Wisconsin, on 18 June 1974 by the Wisconsin Department of Natural Resources. The cost estimate differences referred to at the public meeting were in regard to the difference between utilizing additional pipeline capability for the THOMPSON as presented in the St. Paul District EIS or utilizing a barge transport system as presented in the Rock Island District EIS. The St. Paul District did not develop a cost estimate for a barge removal system due to somewhat questionable nature of reliably estimating the cost of such a system for maintenance of the channel. As indicated in the respective EIS's, the cost estimates are provided to give an indication of the approximate costs of implementing these alternatives as compared to the status quo method, and we believe they accomplish that purpose. More specific cost data, as well as site and material data, would be required to provide a more accurate estimate of costs for the alternatives.

Comment (18, 10): Page 415, First Paragraph, First Sentence - It is stated that few beneficial impacts would result from an increase in the plant capacity itself. We feel that this is not true since the most significant adverse environmental effects which can be attributed to dredge spoil disposal would be alleviated by the proper placement of dredge spoil in areas which are less ecologically sensitive. Although the unit cost for handling of dredge spoil material may increase with additional dredge plant capacity, this extra cost would take into account the true environmental cost of the operating and maintaining of the 9-foot channel.

Response: Comment noted. This information is contained in the referenced paragraph of the draft EIS.

Comment (10): Page 415 - It would be worth mentioning why Congress has imposed a moratorium on the purchase of new dredging equipment.

Response: Concur. The referenced section of the EIS on page 279 has been revised appropriately.

Comment (18): Page 416, Second Paragraph, First Sentence - We wonder how a permanent pool raise would be different than the current situation where pool levels are normal for a limited time of the year, while being higher for the most of the remainder of the year?

Response: The permanent pool raise of 1 foot would have the new normal pool level about 1 foot higher than current normal pool level during that period when the current pool levels are considered to be at the normal level.

The remainder of the year, the water levels would probably be different from the normal levels by degrees comparable to the existing differences. Specific information regarding current situations in the pools is available in the St. Paul District office. The 1-foot pool raise condition would have to be compared with this information to provide specific information at specific points within the various pools.

Comment (11): Pages 416-419 - It also should be mentioned that a permanent pool raise of 1 foot may be very destructive to wildlife habitat, primarily waterfowl and furbearer. Larger open water areas would occur in pools already suffering from a decline in emergent aquatic vegetation. Submerged species would also be affected because of increased turbidity, etc.

Response: Comment noted.

Comment (18): Page 422, Last Sentence - The thinning of submergent aquatic vegetation in areas which are subjected to strong currents or winds could also generate turbidity which would be detrimental to game fish and to the remaining vegetation and water quality.

Response: The final EIS has been revised to include the above information on page 283.

Comment (18): Page 431, First Paragraph, Fourth Sentence - It is stated that increased hydraulic efficiency from dredging, straightening, and overbank clearing has reduced the maximum drawdown to 1 foot. This increased hydraulic efficiency has resulted in sediment deposition causing many sloughs or backwater areas to be virtually cut off from the main flow. In such instances, the sediment deposits serve as a dike by keeping most of the water in the main channel. Therefore, localizing the flow in the main channel through indiscriminate spoil deposition has also helped to improve the hydraulic efficiency of the main channel.

Response: The maximum drawdowns have been reduced in part because of the increased hydraulic efficiency; the increased hydraulic efficiency did not reduce the maximum drawdowns. The increased hydraulic efficiency of the main channel has a tendency to increase the velocity of water in the main channel and subsequently tends to reduce the flow into the off-channel areas. Sediment deposits and dredge spoil areas may act to confine some flow in the main channel but do not necessarily increase the hydraulic efficiency of the main channel.

Comment (18): Page 434, Second Paragraph, Sixth Sentence - The general movement of fish through the locks is supported only by a weak reference to the presence of white bass and fresh water drum above St. Anthony Falls after the locks had been completed. This reference has ignored much stronger published data by the UMRCC and the Wisconsin Department of Natural Resources on the movements of channel catfish, walleye, sauger, and white bass.

Response: The final EIS has been revised to include the information referenced above on page 290.

Comment (10): Page 434 - Migration of the American eel has been curtailed by locks and dams.

Response: The final EIS includes the above information on page 290.

Comment (18): Page 441, Second Paragraph, Last Sentence - The auxiliary locks are presently a popular fishing site for walleye and sauger. Use of the auxiliary locks for recreational boating would adversely affect this fishery.

Response: Comment noted.

Comment (10): Page 442-446 - The commercial use of dredge spoil deserves much broader evaluation and market analysis in the final EIS. Recent publications, such as "Highway News" of the Minnesota Highway Department, cite a growing nationwide shortage of aggregate and sand. Downstream from the St. Paul District, the Mississippi and other rivers are "mined" by commercial operators to obtain such materials.

Response: Several commercial operators along the Mississippi River within the St. Paul District obtain material from the river. However, the selection of the source of material used by commercial operators is currently governed primarily by economics. Since there is an abundance of sand resources within the Upper Mississippi River basin especially in the area adjacent to the Mississippi River within the St. Paul District, the supply in the region far exceeds the demand. The treatment of this alternative measure is felt to be adequate and to convey an objective view of the situation with respect to this alternative measure.

Comment (39): Commencing on or about page 442 and later on page 483 a major case is made for the economic value of dredge spoil for commercial "aggregate" uses. This assumption is completely false and is contrary to basic technical and economic factors pertaining to the aggregate business.

Response: Comment noted. Refer to the previous Comment/Response.

Comment (1): The EIS contains a section on the "Uses of Dredged Material" which presents the beneficial uses of the spoil to neutralize and offset the detrimental impacts of dredging and disposal. The uses of the spoil are divided into three general categories: commercial, recreational, and wildlife habitat. The commercial use of dredging spoils would provide both a direct economic benefit and eliminate some of the adverse environmental effects of the current operation. The cost of delivering dredged spoil to an individual community or company should be compared with the cost of alternative methods of spoil disposal (revegetation, sediment deposition control structures, etc.). At present, some spoil areas receive intense recreational use because of their good accessibility and limited number in a given area. This intense use of available sandy-shoal spoil areas has caused somewhat of a problem in terms of sanitary and solid waste practices. The development of a comprehensive waste disposal program for spoil areas used heavily by recreationists could control both sanitary and solid waste problems and minimize the occurrence of potential health hazards.

Response: Comment noted.

Comment (18): Page 444, First Sentence - These data would seem to support the contention that no new bedload material is being added by tributaries below the Chippewa River since the gradation of the spoil material merely becomes finer. This would be reasonable since as the sediment from the Chippewa River is passed downstream, it would deposit finer and finer material progressively downstream.

Response: The data referenced here is not a sufficient basis to support your agency's contention; it must be supplemented by other information. Refer to the discussion on sedimentation in the Environmental Setting section of the EIS for more information.

Comment (18): Page 445, Item g - Existing laws in Wisconsin would provide adequate controls for the regulation of developments in the floodplain which are not in the public interest.

Response: Comment noted.

Comment (4): Page 445 - Item "h" on this page indicates that the private dredge contractors and sand gravel companies might be adversely affected by any change in market conditions that may occur if this dredged material were available for sale. Since these contractors regularly dredge sand and gravel for commercial purposes, the apparently mutually beneficial option of these contractors performing their dredging in the areas requiring maintenance should be explored and discussed.

Response: The areas dredged and the procedures used by most commercial operators are often much different from those used in the maintenance dredging requirements for the 9-foot channel. The areas where a mutually beneficial operation might be feasible are believed to be very few and as such would only present the possibility for alleviation of a minor portion of the problem.

Comment (18): Page 445, Item h. - Part of the economic impact on private dredge contractors could be offset by awarding contracts to them for providing maintenance dredging on the navigation channel.

Response: Comment noted.

Comment (18): Page 446, Item j - There appears to be no shortage of soft shell turtles which utilize dredge spoil sites for nesting at the present time.

Response: Comment noted.

Comment (18): Page 446, Third Paragraph, Fifth Sentence - It is indicated that the most anyone has stated they would pay for the spoil material is 25 cents per cubic yard located in a suitable stockpile area. This appears to be an unsubstantiated statement since material of this nature was being sold in the La Crosse area this past year for several times 25 cents per cubic yard. As time progresses, certainly this type of material will become more and more valuable.

Response: Based on the quantity, size, and location of the spoil material, we believe the information presented in the EIS is appropriate. The comparability of the prices which your agency references is not known.

Comment (1): Water quality as well as the aesthetics of some pools in the Upper Mississippi River would seemingly have a bearing on the demand for sandy beaches. Where water quality of the river is poor and not suitable or safe for full-body contact, the development of beaches for recreation should be discouraged. The potential health risks of providing beach areas which might induce water-related recreation, i.e., swimming, skiing, etc., where the river is not in compliance with applicable water quality standards should be avoided.

Response: Comment noted.

Comment (18): Page 449, Second Paragraph, First Sentence - Considerations would have to be given to flooding, should camp and picnic facilities be provided on dredge spoil areas. Trash cans and picnic tables would have to be anchored so that they would not be carried away by floods. Sanitary facilities would have to be capable of being pumped out and contained so that contamination of surface waters did not result during flooding. In addition, some form of poison ivy control would be necessary since poison ivy grows in very dense stands on dredge spoil sites.

Response: Comment noted.

Comment (18): Page 452, Second Paragraph, Third Sentence - The development of recreational sites on dredge spoil areas would have to be done in coordination with the non-Federal interests, and such developments would have to be in agreement with their long-range recreational plans.

Response: Comment noted.

Comment (1): Attributing a beneficial use of dredged spoil to provide wildlife habitat may not be valid or reconcilable on a short-term basis. Furthermore, this practice does not take into consideration the loss of one type of habitat for another. The EIS indicated that, in many cases, natural revegetation of spoil areas has not occurred because of repeated deposits of spoil. Also, where woodlands have been subjected to disposal but not with sufficient frequency to cause mortality, the trees have been stunted and the understory has been lost. Usually diverse aquatic or terrestrial habitats are converted into sterile sand shoals and piles, providing a poor substrate for primary succession. Only after many years does the flora diversify enough to support a variety of different fauna. Only diverse growth can ensure biologically productive land.

Response: As noted on page 456 of the draft EIS, present dredge spoiling practices do little to benefit wildlife habitat. If appropriate measures were taken to provide a better habitat for wildlife than would exist if the current practices were continued, such a measure could be considered as having some merit. The desirability and feasibility of such actions would have to be determined on a case-by-case basis.

Comment (18): Page 453, Last Sentence - The possibility of establishing wildlife habitat by "judicious use of dredge material" is discussed. The proposals which have been presented are quite speculative and it is extremely unlikely that such programs could be implemented. In effect, the proposals to establish wildlife habitat with dredge material amounts to a trade-off of previously existing good wetland habitat for poor terrestrial habitat of little value to wildlife. In dealing with water resources, it would seem more prudent and logical to improve the aquatic habitat of the area.

Response: The subject section does refer only to possibilities. Items c, d, e, f, however, refer specifically to possibilities of improving low quality aquatic habitat.

Comment (18): Page 456, First Paragraph, Third Sentence - The terrestrial habitat which was created would not have near the value of the aquatic habitat which was lost.

Response: The implication was only that new habitat would tend to offset the annual increase in spoiled acreage, especially if the spoil sites were adequately revegetated.

Comment (4): Pages 457-576 - The cost figures presented throughout this section should be broken down into components and explained. In addition, the cost of purchasing new equipment should be listed only once because, after purchase, this equipment can be used in each pool.

Response: Due to the preliminary nature of the cost estimates provided, additional information regarding the component elements of the costs is noted and believed necessary for the reader to understand the basic effects and impacts involved with the respective alternative plans. As stated in the text of the EIS, the economic evaluation of equipment for one pool includes accounting for its use throughout the St. Paul District. The use of an alternative plan over the entire District requires a separate evaluation, as the results of each individual pool evaluation are not necessarily cumulative, which can be noted when comparing Exhibit 225 with Exhibits 195 through 208.

Comment (18): Page 457, First Paragraph - While it would appear logical to approach the best alternative concept on a pool-by-pool basis, without the proper background studies of a quantitative and definitive nature, it does not seem that rational alternatives can be selected at this time for each pool. The assignment of cost quantified adverse impacts, plus construction costs of specific alternatives must be included before a rational conclusion can be drawn on the best available alternative. Without such quantification and analysis, the draft Environmental Impact Statement becomes one of economic analysis for expenditures and not one of any overall study to determine the least long-term cost to the public for the 9-foot channel project.

Response: Refer to Exhibits 194 through 208 for quantification of information pertaining to the various alternatives on both a pool-by-pool basis and on the overall St. Paul District basis. The assignment of cost quantified adverse impacts is an extremely difficult and controversial task, as each individual has different value systems. Sufficient information is not currently available to prepare reasonable estimates of cost quantified adverse impacts. As noted on pages 457 through 464 in the draft EIS, as well as in the above-mentioned exhibits, economic, social, and environmental considerations were given evaluation for the various alternatives.

Comment (11): Page 458, lines 12-14 - We recommend the use of confined spoil placement as illustrated on pages 353 and 354. Unconfined spoil placement is one of the major source of sediment in backwaters and other water areas.

Response: Confined disposal was not used in the alternative plan evaluations as discussed in the referenced paragraph primarily due to the lack of documented evidence regarding the true effects of unconfined spoil placement on the backwater areas. Confined disposal measures and subsequent effects could be added to any of the plans listed to gain an indication of what effects this would have.

Comment (11): Page 459 - Regarding revegetation of spoil - we feel that revegetation of existing spoil sites should be included as well as revegetation of new sites.

Response: The old spoil sites were included in the evaluations and consideration given to dredge spoil treatment.

Comment (18): Page 461, last paragraph - The alternative of allowing private dredge contractors to dredge portions of the channel, particularly where there are continual maintenance problems, should have been considered.

Response: Dredging by private dredge contractors would have similar impacts to that which was considered, except that the costs would be different, probably higher with private dredge contractors. This would be considered more appropriately as an alternative measure and not as an alternative plan as discussed in this portion of the alternatives section.

Comment (2): As we understand it, the status quo plan relies upon natural revegetation of spoil areas. Some investment of effort to speed up the process may be justifiable.

Response: Comment noted.

Comment (6): The discussion on revegetation throughout the Alternatives section should be clarified. Although wildlife habitat may be provided by this means, spoiling replaces highly productive fish and wildlife habitat with sand piles and revegetation provides marginal wildlife habitat at best. It is our belief that this situation should be stated in the Irreversible and Irretrievable Commitments of Resources section, page 584, where trade-offs are discussed. The irretrievable losses, both quantative and qualitative, include the highly productive floodplain ecosystems being replaced with spoil deposits of very low productivity, flora, and fauna alike.

Response: The comment in respect to relative productivity is not entirely correct. At the present time the river bottom forests are not considered "highly" productive in terms of wildlife production compared to agricultural lands. Essentially, the lack of nutrients in dredge spoil areas limits both plant growth and the nutritional quality of plant tissues.

Should the application of fertilizers and/or mulch permit quality habitat to become established, there is no valid reason to assume that these same nutrients would not be available to wildlife. Therefore, the potential exists to raise the productivity of these revegetated areas to an equal or higher level than that of the floodplain forest. Presuming that increasing the productivity of revegetated areas is possible, is, perhaps, overly optimisitic. However, results of present revegetation studies should give an idea concerning the value and/or potential of revegetation efforts.

The remaining comments in regards to "trade-offs" are discussed in the Irreversible and Irretrievable Commitments of Resources section of the EIS.

Comment (11): Page 466 - First paragraph of section entitled Upper and Lower St. Anthony Falls, last sentence. Substantial documentation or scientific evidence for the statement that "little of the material is considered to be returned to the main channel requiring redredging" should accompany such a statement.

Response: This assumption was clarified by the words preceding the quoted statement - "For purposes of the alternatives evaluation." Lack of specific evidence of what portion of the material being dredged is being returned to the channel for redredging at a later date requires such an assumption for an alternatives evaluation. Use of other assumptions would possibly provide different comparisons of the alternatives, although it is believed that the evaluation presented is reasonable.

Comment (11): Page 470, second paragraph, last sentence - This paragraph is contradictory. A statement made in Section 3, a "substantial portion of this material is returned to the main channel for redredging" conflicts with the last sentence which states "for purposes of alternatives evaluation, very little of the material is considered to be returned to the main channel requiring redredging."

Response: Refer to the previous Comment/Response.

Comment (18): Page 480, item c - It is not certain whether the twc remote disposal sites would require a total of 50 acres or would each require 50 acres for a total of 100 acres.

Response: This statement has been clarified in final EIS, page 315.

Comment (18): Page 487, first paragraph, second sentence - There is a discrepancy between the statement that "A remnant population of a once common mollusk (Lampsilis higginsi) is alleged to exist in the Hudson, Wisconsin area" and the statement on page 151 that "This mussle is reported from the Hudson, Wisconsin, area of Lake St. Croix, which lies within the study area." There is a considerable difference between "alleged to exist" and is "reported from." Since this species of mussle is listed as threatened and is included on the list of Rare and Endangered Mollusks in the United States, an evaluation should be made on the effect of dredging in Lake St. Croix on this species. In addition, the measures which would be taken to avoid harm to this species should be presented.

Response: Subject sentence has been modified such that "alleged" has been changed to "reported". A statement regarding possible effects of dredging in Lake St. Croix on this species is made in Section 4, "Environmental Impacts" of the final EIS.

Comment (10): Page 488 - The "status quo" alternative would be unacceptable on the St. Croix River in the context of its designation as a National Wild and Scenic River.

Response: Comment noted.

Comment (10): Page 494 - Item d is very meritorious.

Response: Comment noted.

Comment (18): Page 489, item b, second sentence - It is not clear whether selective placement would require four sites with an additional total acreage of 75 acres or if each site would require 75 acres for a total of 300 acres.

Response: The reference information in the draft EIS is considered clear as presented.

Comment (10): Page 495 - We recommend alteration of locking procedures at all locks, but especially locks 3, 5A and 7, to better serve both barge tows and pleasure craft.

Response: Comment noted.

Comment (10): Page 510 - Dredge openings of pool 5 areas mentioned in item d are strongly recommended.

Response: Comment noted.

Comment (18): Page 497, third sentence - It is very unlikely that "brush types" could be planted to make any significant impact on the deer herd especially since starvation is normally not a problem along the Mississippi River Valley.

Response: It was not implied that "significant" impacts would occur. It was implied, however, that brush-shrub plantings might compliment the theoretical grass plantings to increase habitat diversity as well as providing browse for deer. In addition, the significance of shrub plantings would depend on the relative abundance of existing browse.

Comment (18): Page 497, item a, third sentence - It should be recognized that natural channel borders are important ecological niches or edges. These edges provide for a diversity of habitat types and for a diversity of wildlife species.

Response: Comment noted.

Comment (11): Page 498 - "Hanardy Run" should be "Hardy Run."

Response: Correction made in the final EIS.

Comment (18): Page 498, first sentence - It should be noted that this alternative would result in the channelization of 4 miles of the main river border.

Response: The word "channelization" which you have used, carries extensive connotative value and is not an appropriate term to describe the effects which would occur in this location.

Comment (31): Reference last sentence, second paragraph on page 502. This implies that a sediment deposition structure on the Chippewa River has little potential of being an effective aid in establishing the location of acceptable disposal areas or minimizing the cost of new methods. However, it is believed such a structure has the best potential and thorough consideration of this method should be made, not only for the Chippewa but for all other sizeable tributaries.

Response: Such an implication is not intended. Refer to the discussion of sediment deposition control structures on pages 241 to 243 of the final EIS for more information with regard to the effectiveness of this alternative measure.

Comment (18): Page 502, second paragraph, third sentence - One dredging operation is not sufficient to determine if this particular alternative is viable. The abandonment of this alternative appears to resemble an incredulous situation where the "experiment was so successful that it was abandoned."

Response: This alternative has not been abandoned, and no indication of such is implied in the referenced statement. Suggest reference to the sedimentation discussion in the Environmental Setting section, page 74 to 94 of the draft EIS, and sediment deposition control structures, in the Alternative section, pages 347 to 351 in the draft EIS for further discussion relative to the merits of sediment deposition control structures on the Chippewa River.

Comment (31): Reference third paragraph page 502. The description implies locations of structures in the navigation channel. It is my judgment such barriers would have high cost-effectiveness ratios and should be assigned a low priority in further studies.

Response: Comment noted.

Comment (18): Page 503, item d - By looking at Exhibit 37, it is quite easy to see that more than a few openings above and below Lake Pepin may be susceptible to filling due to naturally occurring sediments and secondary movements of dredge spoil material.

Response: Comment noted.

Comment (18): Page 503, item d, second sentence - The upper Lake Pepin sloughs and lakes are located at river mile 790. This is a State-owned wildlife area and is an important waterfowl use area. This area provides valuable wildlife habitat.

Response: Comment noted.

Comment (18): Page 504, item f, third sentence - If dredge spoil material were used to "freshen existing beach areas," we would like to know where the old dredge spoil went to?

Response: No reference is made to old dredge spoil disappearing. Freshening existing beaches refers to placing dredge spoil on existing beaches.

Comment (18): Page 506, first sentence - This is a critical situation which is in need of correction.

Response: Comment noted.

Comment (11): Pages 508-515, (pool 5) - Increasing water levels (see page 511) would definitely be destructive to this pool, as the major problem it currently faces that of declining beds of desirable aquatic vegetation. This pool has probably deteriorated more from spoil deposition than any other one on the river.

Response: Comment noted.

Comment (18): Page 508, second paragraph, last sentence - By consulting Exhibit 37, it can be seen that the stretch of river in the Weaver Bottoms area is a prime example of what continued dredge spoil disposal along the main channel of the Mississippi River will lead to, and what that area would look like in the future. This may be one of the best examples of advanced channelization of the Mississippi River in the entire St. Paul District.

Response: Comment noted.

Comment (18): Page 510, item d - The dredging of openings into backwater areas is considered to be a necessity in order to correct past dredge spoil disposal practices in this area.

Response: Comment noted.

Comment (18): Page 513, second sentence - The hydraulic effects of such barriers with respect to wave action would need to be carefully considered. The reduction of erosive forces of wind would be fine as long as the barriers would allow enough flow and would not constitute a stagnating sediment trap similar to the present spoil deposits in inlets and outlets. These barriers would have to parallel the flow of current and would have to provide for the flow of fresh water through them.

Response: Comment noted.

Comment (11): Page 526, *lines* 19-21 - The alternative to use of Crooked Slough (river miles 726.4) as a spoil disposal site should be carefully considered, as this is considered important wildlife and fish habitat by natural resource agencies and concerned environmental groups.

Response: Comment noted.

Comment (18): Page 532, item b, first sentence - Past spoil deposition on the three islands has resulted in the filling of backwater areas. Spoil deposition on the west river bank across from Winter's Landing has covered four wing dams which provide good fish habitat adjacent to the shore. This instance of filling wing dams is a good example of a violation of the UMRCC dredge spoil survey.

Response: Comment noted.

Comment (18): Page 532, item c, second sentence - We would like to know where this floodplain forest is located since the Wisconsin Department of Natural Resources is studying the possibility of providing a scientific area in the Black River bottoms. This area is a good example of a lowland forest.

Response: Refer to Exhibit 219.

Comment (10): Page 533-534 - The pool 7 Assessment Report indicates that 25-30 percent of the volume of Lake Onalaska has been lost through sedimentation in only 26 years. Dredge openings discussed are highly recommended as is the concept of water level change cited in item f.

Response: Comment noted.

Comment (18): Page 533, item d, third sentence - The inlet to Lake Onalaska just south of Dakota has very likely been affected by dredge spoil. Spring Slough, Gibbs Chute, and Proudfoot Slough are also filling with sand although they are not as close to spoil sites as the other two side channels.

Response: Comment noted.

Comment (18): Page 534, item f, first sentence - Recent water level fluctuations in pool 7 seem to indicate that this may be already a practice.

Response: Two abnormal water level fluctuations were experienced in 1974, one in March and one in May both due to repair work on the locks and dams. Such fluctuations were for a period of less than a week and consisted of a maximum raise of about 1 foot in March and a maximum drawdown of about 1/2 foot in May. These drawdowns are considered abnormal and infrequent.

Comment (18): Page 538, item c, first sentence - We would like to know where these two remote disposal sites would be located?

Response: Refer to Exhibit 219.

Comment (18): Page 539, item d, first sentence - Again, we would like to know where this central disposal site would be located?

Response: Refer to Exhibit 219.

Comment (18): Page 541, first paragraph, second sentence - The depositing of dredge spoil material directly in or above the mouth of Morman Slough could have an adverse impact on the continued supply of fresh water to the Goose Island area which contains valuable waterfowl habitat.

Response: Comment noted.

Comment (18): Deposition of dredge spoil materials near the mouth of Morman Slough would also contribute sediments to the Crosby Slough area.

Response: We have no evidence to confirm such a statement. If your agency has supportive information for this statement, we would appreciate receiving your information.

Comment (18): Page 542, second sentence - The reintroduction of vegetation in the Brownsville-Crosby Slough area would be better than bare sand, but would not be as good as what was originally covered up. Past spoil disposal on Crosby Island has practically eliminated one side channel, while others have been affected, though not blocked completely.

Response: Comment noted.

Comment (18): Page 547, second sentence - It is very likely that this backwater disposal area would adversely affect some of the best duck hunting areas in pool 8 and, therefore, would not be environmentally reasonable.

Response: Comment noted.

Comment (18): Page 551, first sentence - The inlets which have been closed by dredge spoil material should be located and reopened.

Response: Comment noted.

Comment (18): Page 559, item a, fourth sentence - It is stated that two open sand disposal sites are located directly upstream from a slough at river mile 627.9. Any possible secondary movement of sediments has a potential for closing the slough at Wyalusing. In reality, significant secondary movement of sediments has already occurred. A problem exists that high water would move an additional quantity of sediment downstream and close the slough to navigation. In order to prevent this from occurring and in order to maintain the existing character of the slough, it may be necessary to remove the spoil material from the area completely.

Response: Comment noted. Also, refer to Section 4, "Environmental Impacts of Operation and Maintenance," final EIS, page 318 of draft EIS, for additional information.

Comment (18): Page 560, item b, sixth sentence - The McGregor Lake and McMillian Island area have been selected as possible disposal sites. Both of these disposal areas appear to be in the floodway and have been used as disposal site to some extent in the past. Selective placement of spoil material at these sites would not resolve the environmental problems associated with the secondary movement of sediments.

Response: Comment noted.

Comment (18): Page 561, item e, last sentence - It appears that the supply of sand beaches actually creates the demand. If more of these dredge spoil sites were vegetated they would receive more use by wildlife and less use by recreationists.

Response: Comment noted.

Comment (18): Page 571, paragraph one - It should be kept in mind that an alternative action should be judged on the basis of a specific example rather than on generalizations.

Response: Comment noted.

Comment (10): Page 572 - We believe the Corps has more clear authority than it acknowledges to dredge openings to backwater areas.

Response: Refer to comment made by (18) on page 552 .

Comment (18): Page 573, items a and b - Although the net change in aquatic to terrestrial habitat of the status quo plan (1,135 acres) is nearly equal to the selective placement plan (910 acres), the effects of secondary movement of dredge spoil material are not included; however, they could be very important.

Response: Comment noted.

Comment (18): Page 575, item e - The cost of this alternative should not be considered solely on the basis of expediency without an evaluation of environmental and social costs which are attributed to the status quo alternative. This is the only alternative plan that substantially reduces the continued loss of aquatic habitat due to dredge spoil disposal practices which in our mind is a critical issue.

Response: Comment noted.

Comment (41): Page 576 - The final two sentences seem to bias the report in favor of the status quo, ignoring the damage to the environment recognized in the rest of the report. While it is difficult to obtain a quantitative dollar value on the loss in habitat and biota, and the benefit of the projected recreational and habitat improvements, the benefit of the projected recreational and habitat improvements, it must be recognized that it does offset, at least in part, the suggested benefits accrued from barge navigation and the costs of the alternative plans. The importance of the habitats being lost are recognized by several other government agencies, and it is difficult to arrive at a value for recreation use to offset the costs of alternate management plans. The projected cost of acquisition and development in the Iowa plan does give one estimate of the value of the bottomland sites, from the standpoint of replacement costs. The 6-year projection for the north-eastern 14 counties is 3,539,486 dollars for acquisition and 3,739,073 for development. In the last year Iowa in a separate program, the Open Space Land Acquisition Program, has spent two million dollars to acquire land for preservation against future resource need.

While none of these can be directly converted to value of the lands destroyed by dredge spoil it does indicate that these areas have a positive value that must and can be balanced against the low cost of the present program of dredge spoil disposal.

Response: Comment noted.

THE RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

Comment (20): This section is very brief and general. It does not clearly define the relationships nor does it put them in a context which would allow objective evaluation of the relationship. What will the changes in river because of the short-term use mean to future generations?

Response: We disagree with your opinion that Section 6 of the draft EIS "does not clearly define the relationships nor does it put them in a context which would allow objective evaluation of the relationship." The definition of "short-term uses" pertains to the operation and maintenance of the 9-foot channel. Certainly the project could be viewed as only a brief intervention in the geologic aging of the Mississippi River. However, we do not feel that continued operation and maintenance of the 9-foot channel is a short-term use of the environment when viewed in terms of generations of men. We feel that this definition is consistent with the purpose of Section 6 as stated in the opening paragraph of the section.

Comment (4): Pages 576-580 - It should be noted that the fish and wildlife values referred to in this section were also produced prior to the project and likely would have continued without its construction.

Response: We agree that pre-project fish and wildlife values would have likely continued had the project not been constructed. However, these values would have been different from existing ones. The determination of whether pre-project fish and wildlife values would have been better than those now in existence is purely academic. Such a judgement would be subject to individual interpretation.

Comment (18): Page 578, First Paragraph, Third Sentence - Sedimentation in a natural free-flowing stream does not result in the degradation of fish and wildlife habitat since the amount and ratio of deep and shallow water and terrestrial habitat remains fairly constant though their specific location may change with erosion and sedimentation patterns. The unnatural impoundment and dredging situation created by the 9-foot channel transfers flow from the productive biological areas of the backwaters, to the main channel itself. The information which is presently lacking must be obtained in order to answer the relationship between the 9-foot channel project and the continuing decline of habitat for fish and wildlife.

Response: Comment noted.

Comment (10): Page 580 - The movement of all sediments is definitely causing closure of flowing sloughs and the process is not necessarily "unavoidable." It would seem that if the river flow can be directed to follow a navigation channel, it can also be directed to move through flowing sloughs, if it is important enough to the well-being of Man and Nature.

Response: Comment noted.

Comment (18): Page 580 -A critical analysis of Section 6 points out that the best alternative from the short-term and long-term standpoint is the removal of the dredge spoil material from the floodplain completely, unless other information is provided which proves the situation to be otherwise. This conclusion is not in agreement with the basic tone of the alternatives section which implied that the status quo alternative was the best since it cost the least, since there was some natural sedimentation which was happening independent of dredge spoil disposal, and since this alternative had the authorization of Congress.

Response: We do not believe that the information presented in Section 6 leads to this conclusion.

Comment (17): The Environmental Impact Statement should completely discuss the long-term adverse effect of the 9-foot channel. The creation of a series of impoundments in a staircase fashion and the resulting silt and sand deposits due to decreased water velocities would tend to raise the entire valley floor. The increased hydraulic efficiency of the main channel would cause accelerated eutrophication and sedimentation of backwater areas. Past experience with mill ponds throughout the State of Wisconsin provides an indication of what is in store for the various pools of the Mississippi River. Several years after construction of a dam, the lake may provide suitable habitat for fish and waterfowl; however, in time, the lake bed fills with sediment and its value for fish and wildlife habitat decreases correspondingly. Terrestrial species eventually occupy the area. The only solution, although often a partial answer, is to deepen the area by dredging or by raising the water levels. The aquatic habitat provided by many of the pools and backwater areas in the Mississippi River is experiencing the same phenomenon. The natural movement of bedload in the Mississippi River has been retarded by the locks and dams and aggravated by spoil deposition for channel maintenance. At the date of writing of the draft Environmental Impact Statement, 2,370 acres of fish and wildlife habitat have been directly covered by dredge spoil placed in the floodplain, and an average of 2,000,000 cubic yards of dredge spoil is displaced each year in the St. Paul District. It is predicted that the status quo alternative would result in the destruction of an additional 2,705 acres of natural wildlife habitat including about 1,135 acres of aquatic habitat in the next 50 years. An important question which must be considered is which uses of the Mississippi River will future generations value most? It would be reasonably safe to say that future generations would most highly value those uses which were valid, which were currently in short supply, and which were the most difficult to recreate unless a dire necessity required their total consumption. Thus, as the Mississippi River wetlands, sloughs, and backwater areas diminish, their intrinsic value will increase. Discussions on these points should be elaborated upon in Section 7, "Irreversible and Irretrievable Commitments of Resources," and Section 6, "The Relationship Between Local Short-Term Uses of Man's Environment Versus Maintenance and Enhancement of Long-Term Productivity."

Response: The above referenced sections have been modified in the final EIS.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Comment (20): This is essentially a summary of the impacts. The section could be expanded to include information about what the irretrievable commitment of resources means to the study area.

Response: Comment noted.

Comment (10): Pages 581-584—Irreversible commitments should be presented in greater detail, as was done in the Environmental Assessment Reports on this proposed action.

Response: It is believed that the subject section was presented in sufficient detail.

Comment (10, 18): Page 581—The following statement is cited:

> "Habitat losses could be mitigated by commitment of additional resources for restoration. The magnitude of resources required in a restoration effort is usually excessive and, therefore, the effects of environmental degradation are considered irreversible."

The above statement relates to the fundamental question concerning the public commitment to all values associated with the Upper Mississippi River, i.e., "Can we as a Nation afford to operate and maintain a commercial waterway and, at the same time and in the same river system, protect and enhance the natural environment of the resource?" Considering the question in the context of the National Environmental Policy Act and the total public interest, it would be more appropriate to ask, "Can we afford not to do both?"

The statement quoted should be left out of the final EIS. It answers the question negatively and is in direct conflict with NEPA and the entire purpose of rational decision-making embodied in the EIS review process.

Response: Concur. Subject sentence has been modified on page 371 of the final EIS.

Comment (10): Page 582—It would be more meaningful to state O & M fuel consumption for dredging in terms of gallons per year; it appears to be more than 250,000 gallons annually.

Response: Concur. This information has been provided in the final EIS on page 229 .

Comment (18): Page 583, Paragraph One - There would be new colonization of benthic organisms only if sufficient time was allowed between spoiling periods, and if there was little or no secondary movement of dredge spoil material. This would also be dependent upon several environmental parameters such as depth and flow not being changed to the extent that it would preclude recovery.

Response: Concur.

Comment (18): Page 583, Second Paragraph, First Sentence - This is an important comment which points out that the way dredge spoil is managed can serve to encourage or discourage development in the floodplain.

Response: Concur.

Comment (18): Page 584, First Paragraph - It is true that sedimentation is going to occur with or without the 9-foot channel project; however, relocation of flows into the main channel would not necessarily occur without wing dams, closing structures, and the depositing of dredge spoil material along the main channel border. Therefore, the idea that sedimentation is bound to decrease the river's productivity with or without the project is not true. The project as a whole is resulting in decreased fish and wildlife habitat, and measures to alleviate this situation should be a part of the short-term project cost. The last sentence in this paragraph sums up the tradeoff rather succinctly except that it should be pointed out that the tradeoff is between a quality aquatic habitat compared to a low quality and often times sparsely vegetated terrestrial habitat of very low quality for wildlife.

Response: Natural sedimentation, as well as eutrophication and isolation of backwater areas, are believed to be effects that reduce the river's productivity. Costs relative to alleviating habitat degradation were previously discussed in Section 7. Discussions relative to habitat quality are presented in the Environmental Setting section of the final EIS.

COORDINATION

Comment (10): The draft EIS was given wide distribution among Federal and State government officials and agencies, conservation organizations, transportation companies in the waterway and railroad sectors, industrial concerns and public libraries. However, input opportunities for local public officials and private citizens were severely limited by the lack of public hearings or meetings on the document. Considering the extent of public interest in the proposed action, this deficiency is contrary to the spirit of NEPA and related regulations concerning public participation in the decision-making process. Especially noteworthy is the Corps of Engineers' Guideline entitled "The Corps and the Public" (ER 1165-2-500, Appendix A, 30 Nov 70), which states:

> "As a public agency the Corps responds to the public interest. That interest synthesizes many needs, desires and aspirations. It finds expression in the views of individuals and groups and their representatives at local, State and Federal levels of government. We in the Corps of Engineers have an obligation to receive these views, to know what they are and to accommodate them insofar as possible. We are equally obligated to provide information to those who express these views, so that they can understand our activities and responsibilities.
>
> "Our relationship with the American public requires a continuing dialog; without it, we cannot know the public interest. Without such knowledge, the projects that we build are not likely to serve that interest.
>
> "To ensure that we do respond to the public interest, we must seek out its expressions. This is not merely a matter of meeting others half-way; we must do whatever is necessary to obtain the wide range of views which make up the public interest. These often divergent views must be injected into every aspect of our work. They must be introduced during the earliest stage of our consideration of a project and reconsidered at every subsequent stage.
>
> "Among the most important of the views we must obtain and consider are those concerned with environmental values. Altogether too often the environmental viewpoint has not crystallized until a project was under construction. This is not good for those concerned with the environment--their intentions are not realized; it is not good for the Corps--we do not achieve our objectives; it is not good for the American people--their best interests are not served. For these reasons we must take postitive measures to insure that considerations of all elements of the public interest, including the environmental viewpoint, are introduced into each phase of our programs."

To correct this deficiency, the Commission recommends that the Corps' St. Paul District Engineer schedule at least one public meeting in each State (Minnesota, Wisconsin, and Iowa) on the final EIS. This would be consistent with the Corps' Rock Island District schedule of four public hearings on its draft EIS for the same project.

Response: Subsequent to distribution of the draft statement, two public meetings have been held. Refer to the Coordination section of the final EIS.

Comment (20): The EIS indicates that there has been a great deal of coordination through public meetings and dissemination of reports. The final statement should fully incorporate the results of this coordination.

Response: All pertinent coordination that has transpired after issuance of the draft EIS and prior to submission of this final EIS has been included in the final EIS, including the public meetings which were held and the dissemination of the contractor's reports.

Comment (18): Page 587, First Paragraph, Last Sentence - It is our opinion that the draft Environmental Impact Statement should have included a recommendation for future action.

Response: Recommendations for future action are not considered appropriate in an EIS. However, a separate Statement of Findings accompanies the final EIS and contains recommendations for future action.

STATUS OF LITIGATION

Comment (25, 10, 18): In the Exhibits section we recommend inclusion of the latest litigation involving the operation and maintenance of the channel. On March 6, 1974, Judge Doyle of the U.S. District Court for the Western District of Wisconsin ordered the Corps to cease all dredging which would result in the deposit of spoil on Wisconsin lands, when he became convinced of the considerable environmental damage wrought by the Corps. Inclusion of this opinion will place the litigation aspects of the Corps' operation in proper perspective, since it would be misleading to include only the 1973 decision.

Response: Referenced documents are included as Exhibits 230 and 231 in the final EIS.

GENERAL

Comment (10,6,36); A serious deficiency of the draft EIS which greatly hampered efforts to conduct a truly independent review was the omission of many source references throughout the report. A great number of significant statements, tables of data, charts and other exhibits were presented without citation. We find this circumstance most disturbing. It conflicts with the spirit and intent of NEPA and denies to the reviewer the opportunity to evaluate this highly technical, controversial subject from the broadest possible independent frame of reference. CEQ Guidelines, Sec. 1500.8(b) clearly states:

> "Draft statements should indicate at appropriate points in the text any underlying studies, reports, and other information obtained and considered by the agency in preparing the statement including any cost-benefit analyses prepared by the agency, and reports of consulting agencies under the Fish and Wildlife Coordination Act, 16 U.S.C. 661 et seq., and the National Historic Preservation Act of 1966, 16 U.S.C. 470 et seq., where such consultation has taken place. In the case of documents not likely to be easily accessible (such as internal studies or reports), the agency should indicate how such information may be obtained. If such information is attached to the statement, care should be taken to ensure that the statement remains an essentially self-contained instrument, capable of being understood by the reader without the need for undue cross reference."

The fact that the Corps departed from these requirements and from commonly accepted professional practice in this draft EIS is reason enough for questioning the validity of the report. Of even greater concern, however, is the fact that the Corps was given source references by its consultant in the draft Environmental Assessment, and that the Corps chose to eliminate most such references in the draft EIS. No bibliography was provided to furnish necessary reference information on the few citations that were given as required by the Corps' ER 1105-2-507, Appendix C(3) and CEQ Guidelines, Sec. 1500.8(a)(1).

Response: We feel that the draft EIS does meet the intent of NEPA, and is in compliance with CEQ guidelines and Corps ER 1105-2-507. CEQ Guidelines, 1500.8 (a) (1) states: "Highly technical and specialized analyses and data should be avoided in the body of the draft impact statement. Such materials should be attached as appendixes or footnoted with adequate bibliographic references."

Wherever the need to include highly technical and specialized analyses and data occurred, it was either referenced by a footnote or appended

to the EIS in the Exhibits section. The environmental impact assessment reports prepared by North Star Research were used as the basis for much of the content of the EIS. These assessment reports contain extensive bibliographies regarding the source of their material and analyses. The availability of these assessment reports was listed in the Foreward of the draft EIS. Care was taken to assure that the EIS is essentially self-contained, capable of being understood by the reader without the need for undue cross-reference.

Comment (11): The Corps must hold legitimate spoil conferences to alert affected agencies, organizations and individuals of the Corps' immediate dredge spoil plans and to seek guidance from others to minimize environmental damage. The Upper Mississippi River Basin Commission, (UMRBC) through its Dredge Spoil Task Force, can serve as the proper medium for developing those guidelines for solution to the immediate dredge spoil problems of that year.

Response: Dredge spoil conferences are held annually. Additional coordination is conducted as necessary. We concur that the referenced Dredge Spoil Task Force of the UMRBC can serve as a medium for developing guidelines for solutions to immediate dredge spoil problems.

Comment (11): The UMRBC can also serve as a forum to study short term (ten year) volume dredge spoil problems and recommend solutions for time frame as well as long-range problems that would require more extensive solutions. Early indications are that solutions will require multi-agency support since the source of much of the river sediment requiring removal, originates in tributary watersheds where upstream erosion control is needed.

Response: Although the UMRBC is set-up to serve the referenced functions, the ultimate responsibility for completion of studies, and the recommendations and implementations of solutions to the referenced problems, would fall back upon the individual agencies charged with those responsibilities.

Many potential solutions will require multi-agency support, especially those involving erosion control in the tributary watersheds. The implication that upstream erosion control will completely solve the current problems associated with operation and maintenance activities should not be given by this statement. Other potential solutions to these problems within the Mississippi River floodplain may also require multi-agency support.

Comment (11): Inadequate funding to solve some of the problems must be presented by the Corps at its budgetary hearings. To date there is little evidence that Congress has been fully apprised of the problems arising from lack of studies to solve the problems. It is our belief that the Corps is obligated to cite such needs and press their case for adequate programs as studies unfold solutions to these problems.

Response: The Statement of Findings, accompanying this EIS, relates the findings and recommendations of the District Engineer relative to the subject of this EIS. We feel it is improper to recommend major actions on the issue until completion of the final EIS when all interested views have been incorporated. There is currently a funding appropriation request for one million dollars before Congress to initiate studies of the problems and solutions associated with operation and maintenance of the 9-foot navigation channel. The Minnesota-Wisconsin Boundary Area Commission was instrumental in the allocation of this money.

Comment (11): Mitigation measures are proper for replacement of natural resource values lost in any public program wherein project expediency creates unavoidable losses. The Operation and Maintenance of the Mississippi Navigation Channel in the St. Paul District should be no exception. The public's assets in natural resources are not to be expendable for the sake of economic gains. The public must be compensated when such losses occur.

Response: Water resource projects involving expenditures of public funds are implemented to provide maximum public benefit. Changes in the type and quality of natural resources usually occur to varying degrees through implementation of these projects. Whereas, the Fish and Wildlife Coordination Act of 1958 (P.L. 85-624) provides that, for projects not yet completed as of the date of enactment of the law "the project plan shall include such justifiable means and measures for wildlife purposes as the reporting agency finds should be adopted to obtain maximum overall project benefits," and whereas NEPA requires that all impacts and effects of the proposed action be accounted for and that all trade-offs be identified, and whereas Section 1500.13 of the CEQ guidelines relating to Preparation of Environmental Impact Statements states that - -"further incremental major actions be shaped so as to enhance and restore environmental quality as well as to avoid or minimize adverse environmental consequences," it appears obvious that obtaining the maximum overall public benefit is the basic reason for providing mitigation or compensation measures. In instances where provision of compensation measures for natural resource losses is not in the overall public benefit and as such is not undertaken, the trade-offs involved must be recognized.

Provisions of further compensation measures for losses incurred to natural resources in conjunction with the operation and maintenance of the 9-foot navigation channel would be dependent upon the appropriateness of providing such measures within the authorities mentioned above and any other pertinent legislation.

Comment (11): Feasibility studies must precede solutions to many of the current problems associated with the operation and maintenance of the navigation system. The Corps must give priority to such studies to determine feasibility of tributary sediment control, dredge spoil containment, and research into off-channel improvement measures, for example.

Response: We concur that additional studies are necessary prior to finding proper solutions to many of the current problems referenced. The Statement of Findings, accompanying this EIS, carries the recommendations of the District Engineer regarding the findings of the studies conducted in the preparation of the EIS.

Comment (4): The statement was difficult to review because of its organization into text and exhibits sections. This format made it difficult and time consuming to correlate text and exhibits.

Response: Comment noted.

Comment (6): Many of the maps, charts, graphs, and tables are difficult to interpret. Data contained in Exhibits 107, 109, and 110 are graphed in such a manner that they appear to cover a period of time. This is unfortunate since the totals for individual pools should not be connected in this manner. Perhaps a table or a bar graph would more properly illustrate the information.

Response: Certain exhibits may be difficult to interpret due to the nature of the quantities being measured, but on the whole we feel that they are understandable to the average reader. Exhibits 107, 109, and 110 have been altered in the manner suggested in the final EIS.

Comment (10): It would be very helpful to include tables showing total usage of the river for various purposes, especially fishing, hunting, recreational uses, etc. This could be done by combining figures for individual pools.

Response: Although this would undoubtedly be more convenient for some readers we feel that it would not materially enhance the content of the statement.

Comment (10): Maps would be very useful to the understanding and evaluation of the alternative plans, including possible sites for various disposal areas, land treatment and sediment control structures, stockpile areas, dredge opening to backwater areas, etc.

Response: This was considered during preparation of the draft EIS but the effort and cost of preparing such extensive illustrations was not felt to be justified.

Comment (9): There are three hydroelectric power projects licensed by FPC located in the Twin Cities area below the head of navigation. They are the Hennepin Island power plant of Northern States Power Company, located below the Upper St. Anthony Falls dam with an installation of 12,400 kilowatts and the Lower Dam hydroelectric power installation of Northern States Power Company located below the Lower St. Anthony Falls dam with an installed capacity of 8,000 kilowatts. These two projects operate under FPC License Project No. 2056. There is also a power plant

operated by the Ford Motor Company at lock and dam No. 1, This power plant has an installed capacity of 14,400 kilowatts and is operated under FPC license No. 362. The proposed dredging operations above and below the FPC licensed projects will have no apparent adverse affects on the operation. Also, there are a number of natural gas pipelines and electric power transmission lines crossing or adjacent to the navigation channel but these would not be affected by the proposed action assuming the exercise of prudent care in the operation

Response: Comment noted.

Comment (13): The draft Environmental Impact Statement listed above has been reviewed by the Survey and Planning and Archaeology sections of the Minnesota Historical Society as per your request of 21 February 1974. Concurrence with statements regarding archaeological and historic sites as found in the DEIS (pp.164-168, Pool Subsections, and Exhibits) is held by the Minnesota Historical Society. The review recognizes the great abundance of sites along the channel and the difficulty in recording, researching and re-surveying the project area.

Response: Comment noted.

Comment (20): The Metropolitan Council has adopted several policies in its Metropolitan Development Guide which are pertinent to this project. The Corps of Engineers should acknowledge these policies in the final Environmental Impact Statement.

Protection Open Space #15

Any alteration to the shoreline, channel or bottom profile of water bodies and water courses by filling or dredging must be demonstrated by the proponent to the unit of government to be non-detrimental to the resource and must be in accordance with Minnesota Department of Natural Resource requirements.

Protection Open Space #25

Counties, municipalities and other units of government should not allow encroachments into the water courses or floodplains which would reduce their water carrying ability below planned capacity.

Water Resources #13

Areas known to have been inundated by floodwaters or high lake levels should not be filled in, developed or otherwise altered until: 1) A floodplain study has been completed, 2) Floodplain maps have been prepared and a floodway delineated.

Response: The Protection of Open Space and Water Resources policies of the Metropolitan Council's Development Guide have been acknowledged in projects and proposals of other agencies in Section 2 of the final EIS.

Comment (6,24): The statement addresses only one segment of the Mississippi River rather than the entire length affected by the action of "operation and maintenance."

Actually, the authorized "operation and maintenance" (O&M) program for the Mississippi River Nine-Foot Channel includes the entire river reach between St. Paul, Minnesota, and Cairo, Illinois, a distance of 857.6 river miles. Three Districts of the Corps of Engineers (St. Paul, Rock Island, and St. Louis) are responsible for this action. Yet, patterns of water level fluctuation and fluvial hydraulics are matters which are interdependent of the three responsible administrative Districts. Even the many biological and geophysical involvements generated by the project and by O&M itself suggest that this latter action should be treated singularly rather than in parts. Certainly, changes in plant composition and succession, waterfowl movements. and the migratory requirements of several species of fish (including their utilization) recognize no district boundaries of the Corps of Engineers. We suggest that an overview statement be developed to consider the total impacts of O&M from the head of navigation to mile zero at Cairo, Illinois. We understand that 14 or more separate statements eventually will be developed to cover the one program of O&M for the Upper Mississippi River. Such a voluminous undertaking would not seem necessary if the primary issue of O&M was dealt with decisively and not confused with repetitious reference to the effects of initial project inundation of the original floodplain ecosystem (slack water vs. live stream).

Response: This statement was prepared by the St. Paul District and discusses the operation and maintenance activities of the 9-foot channel project within the St. Paul District, and the relationship of these activities to the other district's O&M activities. Although administrative organization was a definite factor in the decision to prepare the statements on a district-by-district basis, many other factors influenced the decision, one of which was the differences in the environmental conditions experienced. An overview statement combining the results of the current statements could be compiled at a later date as a revision to the current EIS, if deemed necessary.

Comment (25): We recommend a complete study of the spoil movement problem. If the study demonstrates that a great amount must be re-dredged each year, then an alternative plan and greater costs now might be justified by less dredging and reduced costs in the future. The study, which might also demonstrate unacceptable backwater damage, should cover the prevailing conditions in each pool and the expectations of spoil return for varying river conditions. It should also attempt to predict the bank erosion which would result if any schemes undertaken should result in reduced sedimentation load on the river.

AD-A133 511 OPERATION AND MAINTENANCE 9-FOOT NAVIGATION CHANNEL UPPER MISSISSIPPI RIV..(U) CORPS OF ENGINEERS ST PAUL MN ST PAUL DISTRICT AUG 74 8/8

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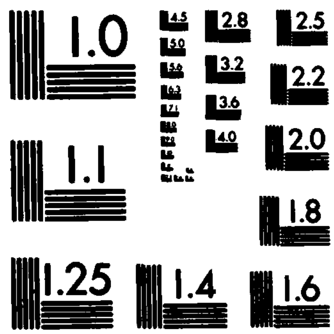

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

We recommend the institution of a monitoring system which would provide information on yearly trends in the food chain and the varieties and extent of plant and animal life in each pool. The Corps could then adjust their operations when it appeared that they led to impairment of the living conditions of important species.

We recommend a detailed inventory of the backwater areas and their conditions in the St. Paul District. After inventory the areas should be continually monitored to provide instant information. Action should be taken to guard these areas from degradation -- even if it involves the dredging of entrances to these areas. The backwater areas are the most important life-sustaining portion of the river -- if we allow the backwater areas to die, the river itself could be next.

In order to alleviate and correct the present inequities involved in the operation and maintenance of the "9-foot" channel, we recommend that a plan be initiated which would bill the users of the waterway according to some equitable scheme. The money collected should thereafter be used to mitigate environmental damage. Environmental costs would thus be passed on to the beneficiaries of the waterway -- where they rightly belong.

Response: The recommendation for a study to monitor spoil movements, a monitoring system on the ecosystems of the pools, and an inventory of the backwater areas, if implemented would provide needed information to more fully understand the complex system of the river. The Corps can implement such studies and activities subject to the limitations of authorities and funding. Current authorities allow such studies only as related to 9-foot channel operation and maintenance activities. The Statement of Findings which accompanies this final EIS discusses the recommendations of the Corps in regard to alleviation of adverse or potentially adverse impacts associated with operation and maintenance of the 9-foot channel project.

The Corps of Engineers currently has no authority to bill users of the 9-foot channel waterway.

Comment (1): We believe the following general approach should be used in dealing with water resources impacts of O&M activities. This approach will designate EPA's general recommendations regarding dredging and spoil disposal in the Upper Mississippi River.

> The need for greater flexibility in the handling and disposal of dredged spoil is required because of the adverse impacts upon environmentally sensitive areas. Additional expenditures for longer pipelines, booster and pump-out equipment and transport barges may be necessary to increase the flexibility of O&M activities.

Response: Comment noted.

Comment (1): The practice of retaining spoil in and adjacent to the waterway should be modified. The adverse effects of the existing program upon water resources and wetlands are apparent. Deposition in the upper reaches of the pools and along the wing dam sectors is obvious from comparative photograph displays in the environmental assessments. Where feasible, we believe spoil should be moved as far away from the river as practicable to prevent if redeposition in the river. This approach will not be necessary in every case, but where shoaling is intense and dredging requirements are extensive, it should be encouraged. Furthermore, if sensitive wetlands or bottomland forests exist in the vicinity, spoil should also be removed to a more compatible area, preferably outside the floodway. Placement in fringes of the floodplain would probably be acceptable.

Response: Although we agree that the current methods of operation and maintenance may be in need of modification, we do not feel that location of dredge spoil sites far away from the river or in the "fringes of the floodplain" are necessarily more desirable than some of the current locations. Each site would have to be considered on a case-by-case basis, as well as on the overall general aspects of the operation and maintenance activities. All aspects of the case, including economic, social, and environmental, would be considered in decision-making. Sensitive environmental areas would receive appropriate recognition as to their true values.

Comment (1): The existing program of selecting spoil disposal sites is in need of modification. Regardless of the fact that infrequent spoilage in some areas has created a few diversified ecosystems, the usual results are sterile sand-shoals that adversely impact, either directly or indirectly through sedimentation and redeposition, environmentally sensitive areas such as spawning and fishing habitats. With care and coordinated agency planning, adverse impacts can be avoided.

Response: Although we feel that our current method of dredge spoil disposal is causing adverse impacts, we do not agree that adverse impacts can be avoided by using care and coordinated agency planning. Additional funding as well as additional plant capability will be necessary to reduce many of the adverse effects associated with current activities.

Comment (1): The load capacity of a given area to successfully retain spoil deposits and support a viable ecosystem is an important factor that has been overlooked in the past and should be given careful study in the future. When selecting sites for disposal, consideration should be given to the frequency of spoil disposal, quality and quantity of spoil, and the type of area affected.

Response: Concur. These factors will be given more consideration in future dredge spoil disposal site selection and in dredging operations.

Comment (1): Bottom sediments of each pool should be periodically monitored (3-year intervals) to determine their quality and character for a compatible program of disposal with local ecosystems. Bottom sediments that are found to be polluted must be confined in a disposal facility.

Response: A program is underway to identify potential dredged areas which are likely to involve polluted material. Following identification of these areas a consultant will be engaged to obtain and analyze samples to determine if the material is polluted. If material to be dredged is found to be polluted, an appropriate disposal method will be enacted.

Comment (1): Pollution abatement measures for minimizing adverse water quality and environmental impacts at selected disposal areas should be planned prior to dredging. Where necessary, pollution control structures should be constructed and completed prior to the disposal of spoil. Stabilization of the disposal area is an important measure that should be implemented after spoil deposition. Stabilization measures such as revegetation are necessary to minimize water and wind erosion and redeposition in the river.

Response: Comment noted.

Comment (1): In order to improve the understanding of O&M activities on the Upper Mississippi River, detailed studies to determine the composition of bottom sediments, short and long range water quality effects, the nature of sediment movement and effects of spoil placement should be undertaken as soon as practicable.

Response: Refer to previous Comment/Response in this section concerning monitoring of spoil movement.

Comment (1): In light of the time restraints on current dredging activity and the provision in your regulations to update or revise a draft EIS when necessary, it is inappropriate to require the following detailed studies be included in this EIS. However, we would expect that such studies would be completed in the near future and the EIS updated to reflect the results of such studies. The information gained should improve future O&M activities to substantially reduce adverse environmental effects from O&M activities in the Upper Mississippi River. Such studies include: a comprehensive bottom sediment analysis on the Upper Mississippi River; the short and long range effects of O&M activities upon water quality in the river and its tributaries; a complete description of the wetlands, backwater areas, and bottomland forests to be impacted by O&M activities including quantity, quality, relative importance and ecosensitivity of these areas in each pool; the general environmental effects of dredging sloughs and backwater areas; the dynamics of sediment movement induced by dredging and disposal activities; and the effects upon the existing Upper Mississippi River floodplain. Long-term effects should take into consideration not only the consequences upon floodplain and lowlands uses, wetlands, bottomland

forests, sloughs, and backwater areas, but also the constriction of the existing meandering waterway, development of a uniform navigation channel, sedimentation and deposition in each pool and associated implications on flood levels.

Response: Refer to previous Comment/Response concerning monitoring of spoil movement. Additional studies regarding the environmental impacts of the operation and maintenance of the 9-foot channel and subsequent revisions to the EIS will be conducted and made as necessary and appropriate.

Comment (40): No modal efficiency or transportation cost comparison has been made by the Corps for any portion of the Upper Mississippi River-Illinois Waterway system. Also, apparently on only one occasion did the Corps ever make a transportation cost comparison in addition to a transportation rate comparison when evaluating the economic justification for any inland navigation project. This one occasion was in connection with the Pittsburgh District Engineer's April 1965 report on economic re-evaluation of the proposed 120-mile, one billion dollar Lake Erie-Ohio River canal project. The modal transportation rate and cost comparison study by Arthur D. Little for the Pittsburgh District Engineer revealed that for the movement of dry bulk cargo, which would constitute 97% of the initial prospective canal traffic, the transportation cost by rail was less than by barge. A total of 92.7% of the transportation rate savings to the prospective waterway shippers would merely represent a transfer of net income from existing rail carriers with no economic benefit or savings in transportation cost to the nation.

Response: Under the Transportation Act of 1967, Section 7a, alternative rates of competing forms of transportation are compared. Costs are assumed to be reflected in the rate structure. It is not true, however, that no cost comparisons have been made by the Corps for the Upper Mississippi River-Illinois Waterway system. Various modal efficiencies have been examined. It should be noted that the Lake Erie-Ohio River canal study is dated April 1965 and preceeds the 1967 Transportation Act.

Comment (40): The fact that the actual rate savings to the waterway shippers is even less than the average amount which they should save by merely not having to contribute to the railroad right-of-way costs and taxes through rail freight charges supports the railroads' contention that, actually, there are little or no net benefits. About all that the waterway accomplishes is to provide a shift in net income from the railroads to the waterway shippers and barge lines. Based on the A. D. Little transportation cost comparison for the Lake Erie-Ohio River canal, the increase in net income to the waterway shippers and barge lines is even less than the loss of net income to the railroads. In view of this situation, it would make more economic sense for the Federal Government to pay a direct

subsidy (to the potential waterway shippers if they were to ship by rail) rather than build, operate and maintain an expensive inland waterway project to merely accomplish the same net result. As explained in the April 29 letter, this would also provide a better deal to all other rail shippers who are not in a position to ship by water.

Response: No demonstration of fact has been established "that the actual rate savings to the waterway shippers is even less than the average amount which they should save by merely not having to contribute to the railroad right-of-way costs and taxes through rail freight charges." Studies and analysis leading to these conclusions if furnished would be fully considered. The conclusions stated, based upon the Lake Erie-Ohio River canal study, are not universally transferrable to movements other than those studied by A. D. Little (except that demonstration is made that similar conclusions are with foundation elsewhere).

Comment (40): The extensive commercial navigation improvements being proposed in the Upper Mississippi River Basin would result in a serious diversion of traffic and much needed income from the railroad industry. As an example, the proposal to replace or duplicate the locks at 18 to 32 existing lock locations on the Upper Mississippi River and Illinois Waterway at a current estimated cost of 1.7 to 2.2 billion dollars would, according to the Corps, increase the annual waterway traffic tonnage in the Upper Mississippi River Basin from the current level of about 65 million tons to an estimated level of about 220 million tons during the next 50 years. Most of this traffic in the absence of the lock replacement or duplication improvements would move by rail. Also, the estimated rate savings to the potential waterway shippers would represent little more than a diversion of potential net income from the railroads.

Response: Comment noted. However, we do not feel that the above material is a subject of concern of the operation and maintenance activities of the 9-foot channel project.

SECTION 10

10. Status of Litigation

10.01 On 19 June 1973, the State of Wisconsin filed an action in Federal District Court for the Western District of Wisconsin seeking to enjoin the Corps of Engineers from depositing dredged spoil in connection with maintenance dredging of the Mississippi River at River Mile 690.2 near La Crosse, Wisconsin. A hearing on the matter was held on 22 June, at which Judge James Doyle ruled from the bench granting the preliminary injunction. He stated that he believed that the activity constituted a major Federal action which did significantly affect the environment. He acknowledged that the Defendants were proceeding in good faith in preparing an Environmental Impact Statement and recognized dredging as a difficult problem. As a result of Judge Doyle's Order, the dredging in question was halted.

10.02 The DREDGE THOMPSON then proceeded to the next required maintenance dredging site which involved disposal in Minnesota. Upon completing that work, the DREDGE once again moved to the Wisconsin side of the river. On 28 June 1973, Plaintiffs filed an amended Complaint seeking to enjoin the dredging about to take place. A hearing was held in Federal District Court on 29 June. As a result of that hearing, Judge Doyle denied the injunction sought, essentially because the Defendants had not had sufficient time to prepare a case and because he considered the matter too significant to deal with without such time being allowed. The judge analyzed the schedule of maintenance dredging activities remaining and noted that a separate dredging project was scheduled to begin on 10 July. He advised the Plaintiffs that if they would file an action by 2 or 3 July, seeking to halt that dredging project, a hearing on that matter would be scheduled for 9 July.

10.03 On 3 July 1973, the Plaintiffs filed an amended Complaint and on 9 July, the hearing was held. On 10 July, Judge Doyle issued an Opinion and Order denying the injunction, and lifting the injunction previously issued on 19 June. The Complaint filed by the Plaintiffs, the Answer filed by the U.S. Government, and the Court Opinion of 10 July, are shown in Exhibits 227, 228 and 229 respectively.

10.04 On 6 March 1974, Judge Doyle issued an Opinion and Order granting the Plaintiff's Motion for Summary Judgment and enjoining spoil deposition within the boundaries of the State of Wisconsin. The Decision was based upon the Judge's determination that the maintenance dredging of the Upper Mississippi River requires an Environmental Impact Statement and that in the absence of such a statement, the activity should not be allowed to continue. The 6 March Opinion and Order noted that dredging may be permitted on an emergency basis following application to the court for permission.

On 2 May 1974, the Defendents filed a Motion to have the 6 March 1974 Order amended. On 7 May 1974, Judge Doyle granted the Motion and amended his earlier Order. The Amended Order allows for maintenance dredging at certain locations based upon parameters contained in the Order. Both the 6 March Opinion and Order and the 7 May Amended Order are included as Exhibits 230 and 231 respectively.

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